10.12.2021

Soumendu Chatterjee
Professor & Head
Department of Geography
Presidency University
86/1, College Street, Kol.-73

SYNOPSIS

for

Pre-Submission Seminar

of

Ph.D. Research in Geography

on

Agro-Economic Viability of Betel Leaf Industry - A Case Study in Tamluk Sub-Division of Purba Medinipur District, West Bengal

submitted by

Manas Hudait, M.Sc.

Registration No.: R-16RS12110078

Date of Registration: 14th March, 2017

Department of Geography

Faculty of Natural and Mathematical Sciences

Presidency University

Kolkata

2021

Approved

21/12/2021

PRESIDENCY UNIVERSITY
KOLKATA

SYNOPSIS

for

Pre-Submission Seminar

of

Ph.D. Research in Geography

on

10.12.2021

Soumendu Chatterjee
Professor & Head
Department of Geography
Presidency University
86/1, College Street, Kol.-73

Agro-Economic Viability of Betel Leaf Industry - A Case Study in Tamluk Sub-Division of Purba Medinipur District, West Bengal

submitted by

Manas Hudait, M.Sc.

Registration No.: R-16RS12110078

Date of Registration: 14th March, 2017

Department of Geography

Faculty of Natural and Mathematical Sciences

Presidency University

Kolkata

2021

PRESIDENCY UNIVERSITY
KOLKATA

10.12.2021

Soumendu Chatterjee
Professor & Head
Department of Geography
Presidency University
86/1, College Street, Kol.-73

SYNOPSIS

for

Pre-Submission Seminar

of

Ph.D. Research in Geography

on

Agro-Economic Viability of Betel Leaf Industry - A Case Study in Tamluk Sub-Division of Purba Medinipur District, West Bengal

submitted by

Manas Hudait, M.Sc.

Registration No.: R-16RS12110078

Date of Registration: 14th March, 2017

Department of Geography

Faculty of Natural and Mathematical Sciences

Presidency University

Kolkata

2021

PRESIDENCY UNIVERSITY
KOLKATA

SYNOPSIS

for

Pre-Submission Seminar

of

Ph.D. Research in Geography

on

Agro-Economic Viability of Betel Leaf Industry - A Case Study in Tamluk Sub-Division of Purba Medinipur District, West Bengal

submitted by

Manas Hudait, M.Sc.

Registration No.: R-16RS12110078

Date of Registration: 14th March, 2017

Department of Geography

Faculty of Natural and Mathematical Sciences

Presidency University

Kolkata

2021

PRESIDENCY UNIVERSITY
KOLKATA

Priya Sangameswaran

20-12-2021

Agro-Economic Viability of Betel Leaf Industry - A Case Study in Tamluk Sub-Division of Purba Medinipur District, West Bengal

Introduction

Protecting farmers from agriculture variability is a long-standing concern, especially as the condition of small and marginal farmers, continues to be unstable (National Agriculture Policy 2000; Ministry of Agriculture, Govt. of India, 2007; National Policy for Farmers, 2007). Investigating the spatio-temporal setting, distribution and variation of farming, together with its physical and non-physical bases is therefore key (Singh and Dhillon, 1984). The present doctoral thesis stems from the philosophical standpoint that a detailed analysis of farms'/farmers' agricultural and economic viability is crucial for judging the efficacy of betel leaf agribusiness as a necessary prerequisite for its future development. The primary focus of this study is thus an in-depth analysis of the various agricultural and economic factors related to betel leaf farming from the farmers and other stakeholders points of view (i.e. from cultivation to marketing of the betel leaves), and their operations and linkages. In keeping with the thesis title, the work done is of an investigative nature and involves extensive use of both traditional geographical and economic analysis tools as well as recent RS-GIS datasets and software.

The betel leaf crop has a nationwide acreage of around 36,000 hectares with an annual turnover of Rs. 650 crores in India (Nalwadi et al., 1997). In West Bengal, 5 lakh farming families pursue this trade, with about Rs. 100 crores being earned annually. The dominant local varieties are *Bangla, Sanchi, Mitha* (Ministry of Agriculture, GoI, 2005). Within West Bengal, Tamluk Sub-Division in Purba Medinipur District is famous for the quantity and quality of its betel leaf crop (ICAR, 1997). Despite its importance as a cash crop, storage and transportation facilities are poor, hampering profitability (NABCONS, 2007). The pathway from farm to eventual consumption is a tightly-knit system and disturbances in input factors often disrupt the entire chain. Therefore, it is important to identify the different factors of cultivation, marketing channels and their costs that affects farmers' profits and the price increment and differentials involved in its cultivation and marketing, as these have bearing on the continued viability of the crop's production and marketing in this location.

Study area

Purba Medinipur district is located in the south-western part of the eastern Indian state of West Bengal and is predominantly an agriculturally prosperous area. Tamluk Sub-Division lies in the northern part of this district (Fig. 1), between 21°57′46″N to 22°25′42″N latitudes and 88°00′51″E to 88°7′41″E longitudes. It is comprised of Kolaghat, Sahid Matangini, Panskura,

Tamluk, Moyna, Nandakumar and Chandipur Blocks. This Sub-Division consists of 83 Gram Panchayats (GP) and 858 mouzas in all, including 5 towns. The area experiences a typical monsoon climate and is underlain by riverine alluvium with some tidal tracts. The average annual rainfall is 1470 mm and the average minimum and maximum temperatures range from 21°C to 25°C and 31.8°C to 38°C, respectively. It is mainly covered by loamy clayey soil, except in Chandipur Block, where saline coastal patches exist. According to the 2011 Indian Census, the Sub-Division's total population is 1791695, of which 87.85% are ruralites, the majority of whom are engaged in agricultural pursuits.

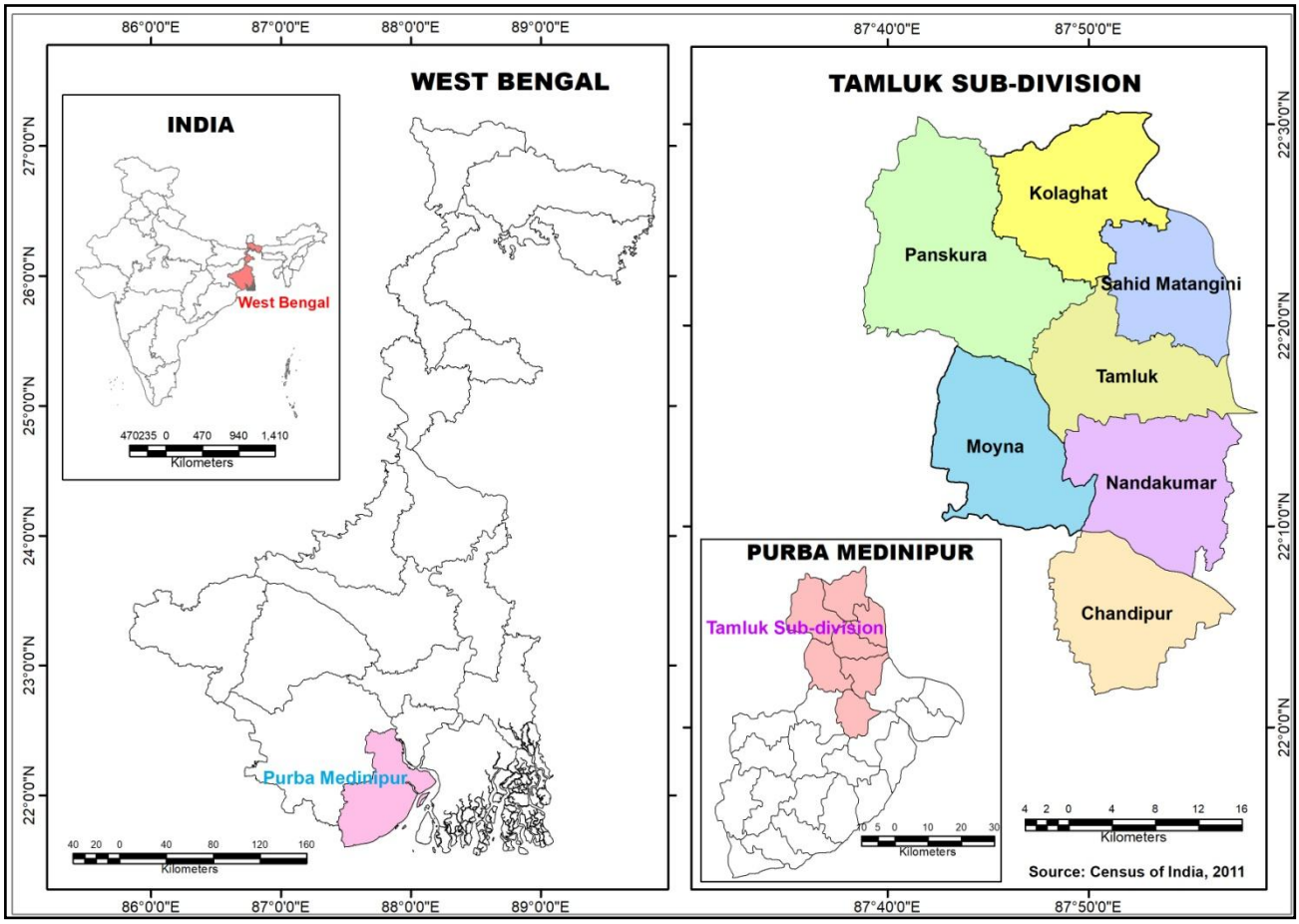


Fig. 1: Location of the study area

Context of the proposed research

Only a few studies have examined the cultivation and marketing of betel leaves in different states of India. Especially in West Bengal, very few systematic studies have been conducted on the production and marketing of betel leaf in a combined manner, apart from some research on the marketing aspects. Also, no recent studies have been done in Purba Medinipur district as well as Tamluk Sub-Division in this regard. Moreover, the acreage under production and number of holdings under betel vine cultivation has steadily decreased in Purba Medinipur

district (Table 1) as well as Tamluk Sub-Division (from 1224 ha in 1995-96 to 644 ha in 2015-16) in recent times. Thus, this study was undertaken to succinctly examine the factors affecting betel leaf cultivation and trade in this region.

Table 1: Estimated area (ha) by land size class under betel vine in Purba Medinipur

Year	1995 -96		2000 - 01		2005 - 06		2010 - 11	
Size Class (Ha)	**No. of Holdings**	**Total Area**	**No. of Holdings**	**Total Area**	**No. of Holdings**	**Total Area**	**No. of Holdings**	**Total Area**
Marginal (0 - 1.0)	46171	4040	20901	2237	19586	2125	6587	782
Small (1.0 -2.0)	4696	520	983	134	1836	292	1012	202
Semi-medium (2.0 - 4.0)	650	62	108	13	163	25	83	6
Medium (4.0 - 10.0)	19	2	6	2	0	0	0	0
Large (10.0 & Above)	0	0	0	0	0	0	0	0
Total	**51536**	**4624**	**21998**	**2386**	**21585**	**2442**	**7682**	**989**

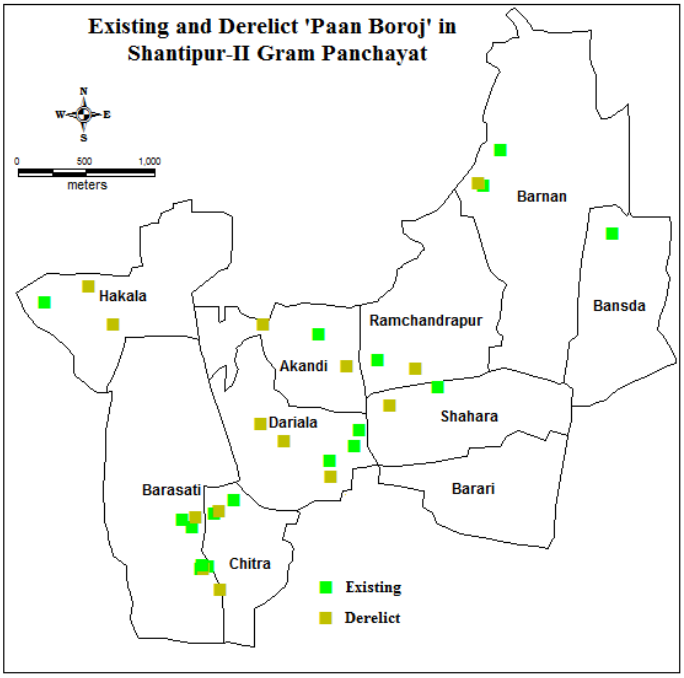
Source: Agricultural Census (different years)

Also, initial surveys in Shantipur-II GP of Sahid Matangini Block revealed that the number of *Boroj*s (sheds within which betel vines are reared) had indeed decreased (Fig. 2). Market related issues too came to the fore (Plate 1) in the form of farmers' protest in betel leaf markets (*Mandi*). Thus, there was a need to examine the spatiality of the production and marketing of betel leaves, which impacts on its profit, and the conditions of the different stakeholders along its value chain, and the problems incurred during the production and marketing process which can wean away people from this industry.

Identified research gaps

After a detailed review of the relevant literature, the following gaps were identified-

- In any agricultural or horticultural crop's production and marketing, linkages play a very important role. Yet no such study properly describes the cultivation and supply chain structure or linkage of the betel leaf industry, which is crucial for its overall development.
- While many studies exist on cropland suitability for different crops, none have been conducted on betel leaf cropland suitability, which can engender much agricultural viability.
- Some studies exist on cost-benefit analysis of betel vine cultivation, but no recent studies have been conducted in Tamluk Sub-Division, which is traditionally famous for betel leaves.
- No past studies on betel leaf industry considering all the stakeholders who together govern the cultivation to eventual sale of the crop.



The Statesman
STATESMAN NEWS SERVICE
KOLKATA, 11 DECEMBER
OUTRAGE
Farmers throw betel leaves during violence at a trading market in Tamluk, East Midnapur on Monday.

Fig. 2: Existing and derelict betel vine *Boroj*

Plate 1: Farmer protest in betel leaf market

Research questions

- Why has the acreage under betel leaf cultivation decreased in the study area?
- Is the land is suitable enough to be agriculturally viable for betel leaf cultivation?
- Whether the current marketing arrangements are viable for farmers?
- How are betel leaf farmers here linked with marketing stakeholders spatially and economically?
- What are the problems faced in the cultivation and marketing processes of this crop?
- Are there any government policies for the betel leaf agri-industry's sustenance and development?

Objectives

- To identify and analyze the linkages between cultivators and other stakeholders in the betel leaf value chain and decipher the factors influencing these relations together with their spatial variations.

- To perform agricultural suitability and economic analysis of betel leaf cultivation and marketing to examine the viability of this region as a leaf growing and marketing centre.

- To identify the existing constraints and examine possibilities for the development of the betel leaf agribusiness industry herein.

Datasets and methods

- All necessary office statistics and information regarding agricultural and socio-economic conditions of the study area were collected from institutions/offices in Tamluk and Kolkata.
- *Boroj* mapping was done on Google Earth platform, based on which field sampling was done.
- Sentinel 2A data was collected from ESA Sentinel Hub for acreage analysis of betel leaf *Boroj*.
- Slope and relative relief parameters were derived from SRTM DEM of 30 m spatial resolution.
- LULC data was extracted from the block-wise 1:50,000 scale maps of the L&LR Dept., GoWB.
- The soil texture and drainage layers were obtained from the District Planning Map Series sheet for Purba Medinipur, prepared by NATMO, Kolkata.
- Monthly rainfall and temperature data were obtained from Worldclim repository for 1960-2018.
- Due to the lack of proper secondary data on betel leaf farmers and acreage, all betel vine sheds (*Boroj*) were first digitized from high resolution Google Earth images, wherein these are clearly visible. Depending on their spatial distribution, betel leaf plots and farmers were chosen. Simple random sampling was used to select 36 betel vine plots for soil sample collection and stratified random sampling was used to choose farms for interviews with farmers. Soil chemical properties like organic carbon (OC) content, electrical conductivity (EC), pH and nitrogen (N), phosphorus (P) and potassium (K) concentration values were ascertained via laboratory analysis in State Agriculture Management & Extension Training Institute and Agricultural Training Centre at Ramkrishna Mission Ashrama, Narendrapur.
- The metalled and unmetalled roads within the study area were digitized from Google Earth and the locations of the various betel leaf markets were plotted after collecting their site information.
- Extensive field surveys were done to collect data regarding agricultural and socio-economic information from farmers and market information was collected from marketing stakeholders using a detailed questionnaire after an initial pilot survey. All the data were then tabulated and analyzed in MS excel and SPSS software to meet the above objectives (all tables presented here are sourced from the data obtained during field surveys, unless otherwise stated). GPS readings were taken for ground truthing of satellite images, soil sample plot mapping and identification of market locations. All the images have been digitally processed and analyzed using ERDAS IMAGINE, SNAP for rectification, signature collection, spectral separability and plotting, NDVI mapping and detection of changes in land cover. QGIS, ArcGIS and MapInfo software were used for generation/management of the geo-database. Econometric analysis was done with the help of Oracle Crystal Ball software to predict the uncertainty towards profit generation.

The general methodology adopted is shown in Fig. 3 and the respective detailed methods to fulfil each objective are discussed separately in the individual chapters.

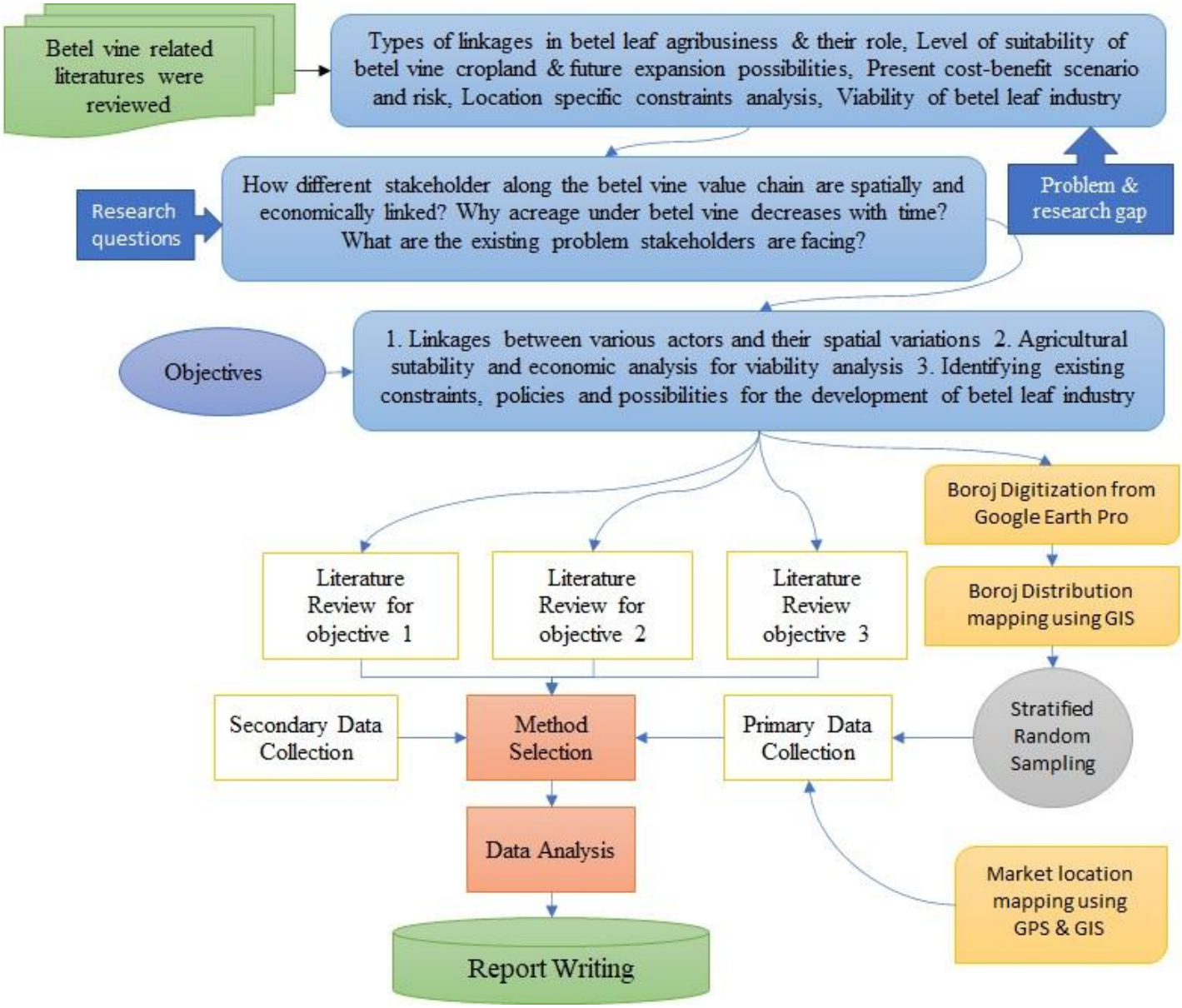

Betel vine related literatures were reviewed
Types of linkages in betel leaf agribusiness & their role, Level of suitability of betel vine cropland & future expansion possibilities, Present cost-benefit scenario and risk, Location specific constraints analysis, Viability of betel leaf industry
Problem & research gap
Research questions
How different stakeholder along the betel vine value chain are spatially and economically linked? Why acreage under betel vine decreases with time? What are the existing problem stakeholders are facing?
Objectives
1. Linkages between various actors and their spatial variations 2. Agricultural sutability and economic analysis for viability analysis 3. Identifying existing constraints, policies and possibilities for the development of betel leaf industry
Boroj Digitization from Google Earth Pro
Boroj Distribution mapping using GIS
Literature Review for objective 1
Literature Review for objective 2
Literature Review objective 3
Secondary Data Collection
Method Selection
Primary Data Collection
Stratified Random Sampling
Data Analysis
Market location mapping using GPS & GIS
Report Writing

Fig. 3: Methodological flowchart of the thesis

Sampling strategy

The present study is based on extensive primary surveys as little secondary data is available. The farm households that were surveyed were selected using multistage random sampling method. Since data is not available on the actual number of farming households that cultivate betel leaf, at first, all the betel vine *Borojs* (the bamboo and thatch shed within which the leaves are grown) were digitised (Plate 2) from high-resolution Google Earth Pro image (where these are clearly identifiable as rectangular features) to identify their number and distribution (Fig. 4). A total of 40,691 *Borojs* were digitized. From this dataset, 27 GPs (out of 83 GPs in all) in the seven Blocks of Tamluk Sub-Division were selected based on these having a higher/lower concentration of betel vine *Boroj* to obtain an even picture across the entire area (highest *Boroj* count in a GP was 2781 and lowest was nil; mean= 490, std. dev.= 722). Within these 27 GPs, a total of 110 farms were chosen randomly

and surveyed using a structured questionnaire (Fig. 5). The respondent sample size was restricted as only minor variations existed among the responses obtained. Qualitative data was obtained through group discussions and interviews with betel vine farmers about the expenses and requirements for betel vine farm setup and *Boroj* construction, the betel leaf agro-ecological system, interculture, soil fertility management, disease/pest control, leaf plucking and packing, markets and marketing systems and the problems faced. In all, 102 marketing stakeholders (50 *Aratdar*s and 52 commission agents/traders) were chosen randomly from all the markets for a separate questionnaire survey.

Plate 2: Identified and digitized *Boroj*s from Google Earth Pro images

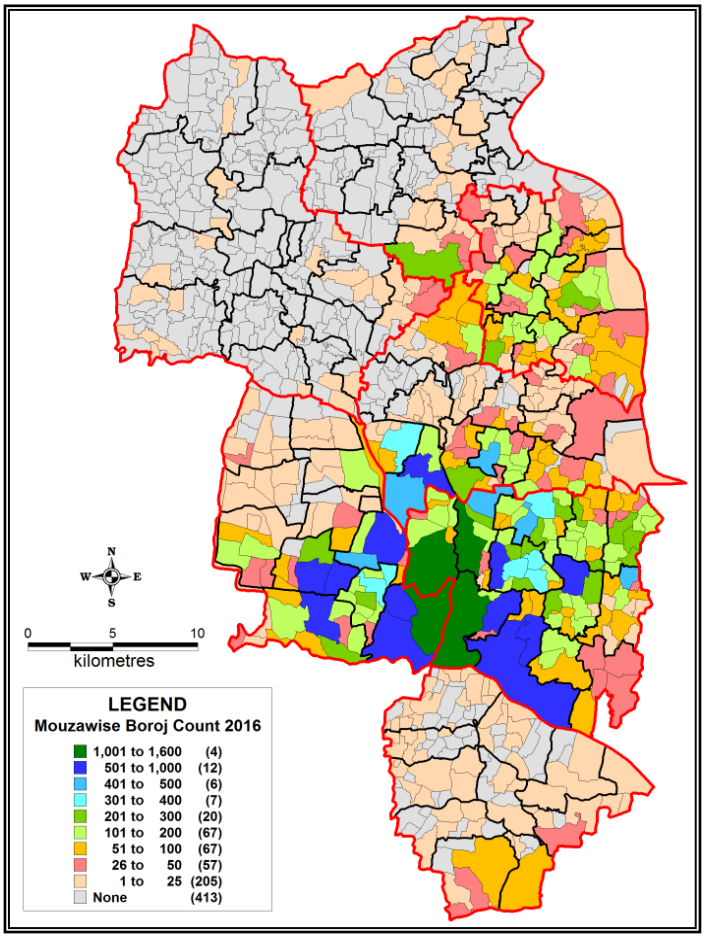


Fig. 4: Betel vine *Boroj* distribution

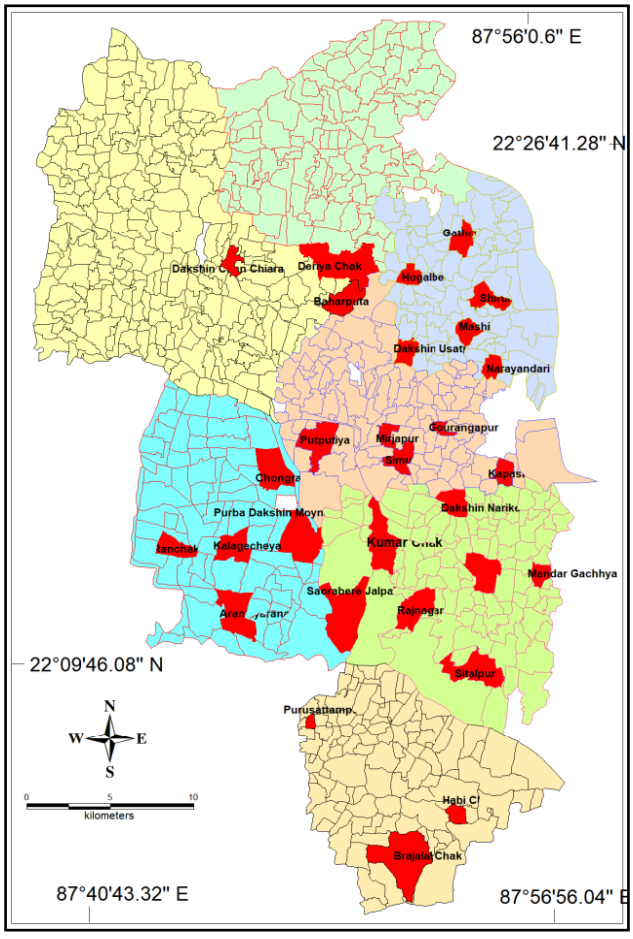


Fig. 5: Selected mouzas for farmer survey

Socio-demographic characteristics of the sampled respondents

Among the sampled respondents, most (50.9%) were between 51-60 years of age while those ≤ 40 years (8.2%) comprised the lowest proportion, signifying the relatively lower interest among younger generations to undertake betel leaf cultivation. The educational attainments of the farmers ranged from Upper Primary (48.2%), Primary (26.4%), Madhyamik (Secondary school) (20.0%), Higher Secondary (4.5%) and Graduation level (0.9%). The most prevalent primary occupation was of combined paddy and betel leaf cultivation (for 77.3% of the respondents), followed by those who only cultivated betel leaves (20.9%). Average number of dependent people per family is ~3 among farmers who have ≤ 20 decimal land under betel leaf cultivation (1 decimal = 40.46 sq.m). This is ~4 and ~3 for those who have 20 - 40 decimal and >40 decimal land under betel leaf cultivation, respectively.

Age structure of the marketing stakeholders is quite different as 45% *Aratdar*s are between 51 to 60 years, while 53.81% commission agents or traders are between 41 to 50 years of age. *Aratdar*s aged >60 years comprised 32% of respondents, while commission agents or traders in this category is only 11.50%. 46% *Aratdar*s have completed secondary education and 46.2% commission agents have completed higher secondary education. 52% *Aratdar*s had 21 to 30 years of experience in betel leaf marketing while 69.2% commission agents or traders had 16 to 30 years of experience. Only 2% *Aratdar*s had <10 years less experience while 19.2% traders had <15 years experience. 44% *Aratdar*s purchase both *Bangla* and *Mitha* varieties of betel leaf, while 24%, 28% and 4% of *Aratdar*s buy only *Bangla*, *Mitha* and *Sanchi* leaves, respectively. Conversely, 42.3% commission agents buy both *Bangla* and *Mitha* leaves while 19.2%, 34.6% and 3.8% of commission agents/traders procure only one of *Bangla*, *Mitha* or *Sanchi* leaves.

Chapterisation

Chapter- I **Introduction**

Overview of betel leaf as a plantation crop and present cultivation status
Literature review and existing research gaps
Research context and questions; Objectives; Methodological framework
Sampling strategy, data collection and analytical methods
The study's scope, significance and limitations

Chapter – II **The study area: Tamluk Sub-Division**

Location and administrative setup
Physiographic aspects, Land use and land cover attributes
Agricultural pursuits and rural economic base
Demographic and socio-economic parameters of respondents

Chapter – III **Betel leaf ecology and cultivation**

Plant types, physiological attributes and phenology
Cultivation methods and betel vine farm (*Boroj*) establishment
Mapping the betel vine *Boroj*s
Crop requirements, interculture and maintenance; Threats: diseases and pests
Plucking, packing and transportation

Chapter- IV **Spatial and economic linkages in betel leaf agribusiness**

Linkage type and temporal changes; Betel leaf market attributes and channels
Market connectivity and accessibility, hierarchy and hinterlands
Main national and international markets and pathways

Chapter- V **Suitability analysis of betel leaf cultivation**

Irrigation and soil factors; Land suitability and *Boroj* site suitability analysis
Expansion possibilities

Chapter – VI **Agro-economic viability of betel leaf cultivation and marketing**

Acreage and production changes: influencing factors
Boroj establishment, operation and maintenance cost
Cultivation and marketing constraints
Betel leaf price: seasonal variations and forecast
Price spread analysis of different marketing channels
Cost-Benefit analysis: Benefit-Cost Ratio and Net Present Value
Monte Carlo simulation and sensitivity analysis;
Economic and Marketing Efficiency; Analysis of Government role

Chapter - VII **Effect of episodic disturbances and continued viability**

Pre- and post-COVID-19 situational analysis; Amphan super-cyclone effect
Consumer preference and demand
Circular Economy approach to betel leaf cultivation; SWOT analysis

Chapter – VIII **Summary and conclusion**

Continued sustainability of betel leaf agribusiness
Recommendations; Future research scope

Chapter-wise summary of the main analyses done

Chapter – III **Betel leaf ecology and cultivation**

Architecture of the *Boroj* and layout of the betel vine field

Field surveys were done to measure the internal layout and external dimensions of a number of betel vine fields and *Boroj* architecture. The *Boroj* is a straw-thatched shed which is erected in order to cultivate the plant and to shelter it from inclement weather elements. They are distinctive and stand out prominently from other built structures, being square or rectangular in planform. The measurement of the internal dimensions and spacing of the individual betel vine rows and their respective plants also enables an enumeration of the number of leaves likely to be procured from each *Boroj*. This structure is usually about six feet height and is primarily constructed of bamboo, jute sticks and straw (Plate 3). These are mainly located on relatively higher surfaces, with sloping surfaces preferred to allow quick drainage and with a pond nearby, from where irrigation is possible (Singh 1994). The side walls are strengthened with bamboo poles and the tops with longitudinally divided with further bamboo poles, and also supported by bamboo posts inside the *Boroj*. Criss-cross supporting poles are used to build the *Boroj* strongly and lend structural strength. The walls are covered with jute sticks, paddy straw, *Khari* and *Joon* grass while the top of the *Boroj* is usually covered with *Khari* and jute sticks. After initial levelling of the land, it is raised by a few inches in order to facilitate drainage and consecutive rows and furrows are prepared. Usually 4-6 inches deep grooves are made between 8-12 inches wide rows. Seedlings are planted 10-16 inches apart along the rows and jute sticks are placed for supporting the creepers properly (Fig. 6).

- **Planting season**: In the study area, betel vine planting is mainly done in early summer (March-April), early monsoon season (July) and before winter (late September and October).
- **Vine or sapling type**: Usually, small cuttings of matured and healthy betel vine are used as a sapling for new betel vine plantation. The vine cuttings must have 2-4 leaves and 2 or more than two nodes, although vines having 4-5 leaves and 3-4 nodes are preferable. Also, vines with root was used sometimes by some cultivators for quick harvesting.
- **Agro-climatic requirements**: Betel vines grow well when the annual rainfall is between 2250-4750 mm and the climate is of the tropical humid variety (Guha, 2006; Beura, 2007), though it can also be cultivated in areas receiving between 1500-1700 mm rainfall during the year, provided irrigation is available (Singh, 1994; Jana, 1995; Mishra et al., 1997; Herath, 2015). Betel vines prefer temperatures between 15°C - 40°C (Singh, 1994; Guha, 2006; Herath, 2015; Bhakta, 2017). They grow in a wide variety of soils, ranging from sandy loams to clayey loams

(Reddy, 2015), but it is best suited to well-drained lateritic and clayey loam soils (Guha and Jain, 1997; Guha 2006; Bhakta, 2017). Soils with pH values from 5.6-8.2 are suitable for betel vine cultivation (CSIR, 1969; Guha and Jain, 1997, Guha, 2006). While the OC requirement for betel vine can suffice at just 0.56-0.78%, higher values of around 1.3% OC give the maximum yields (Saravaran and Maiti, 2008).

- **Intercultural Operation**: As the vines grow and reach the *Boroj* roof, they are pruned down about 4 – 5 times a year depending on the leaf variety and growth rate to obtain a good amount and quality of leaves.
- **Diseases and Pest**: Since betel vine is a very sensitive crop, it is frequently affected by various pests and diseases. The most common diseases are foot rot disease (locally called *Angari*), leaf rot disease (*Fopsa*) leaf spot disease (*Chitla*). These incur heavy expenses, needing much care and capital. The common insects found in betel leaf are white fly and capnodium spp.

Plate 3: *Boroj* construction and architecture

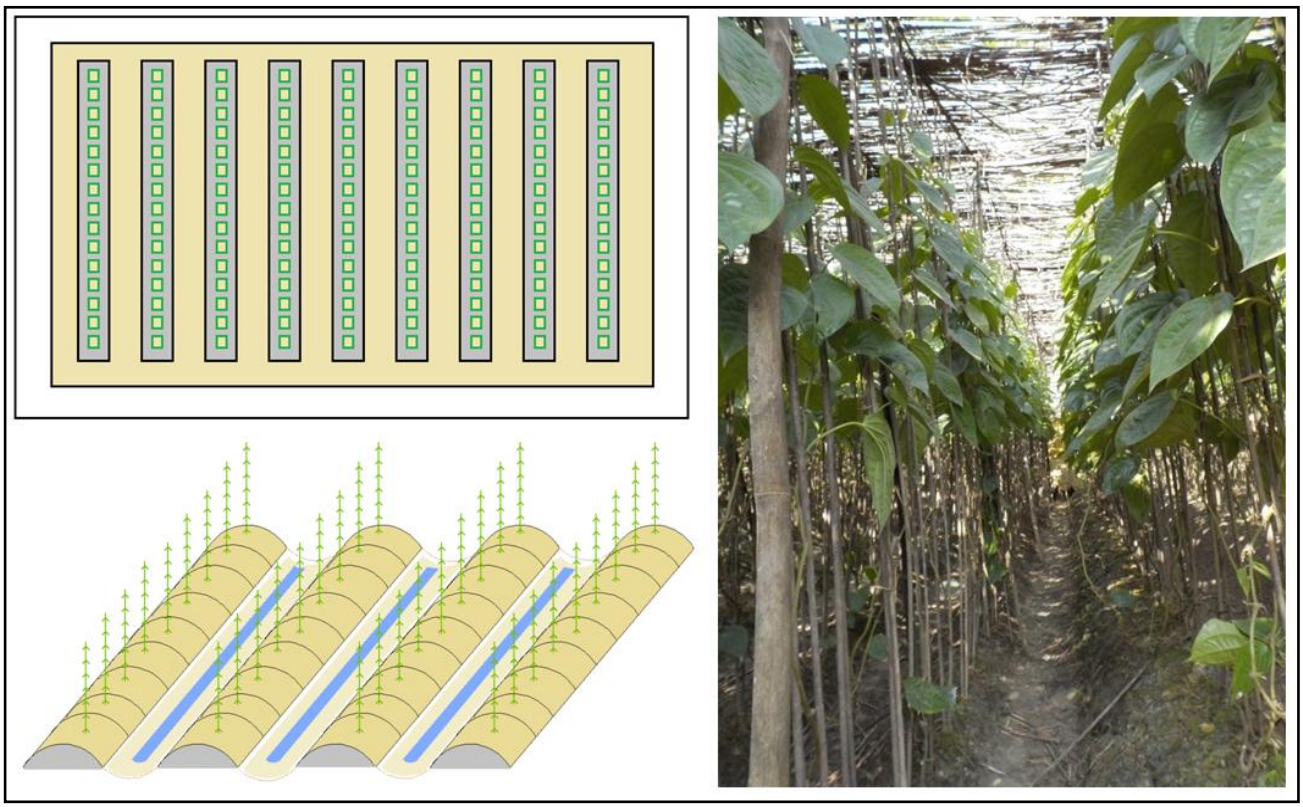


Fig. 6: Internal layout of betel vine *Boroj*

Chapter- IV **Spatial and economic linkages in betel leaf agribusiness**

The methods (Fig. 7) followed to meet the stated objectives were as follows-

- Primary surveys (markets/farms) were undertaken to identify spatial/economic linkages and value chain analysis. The linkage between the farmers, other stakeholders and consumers was identified through interviews and through it changes in linkage from past to present were also noted. Supply chains were identified and price spread analysis was done for the different marketing channels.
- Network analysis was conducted to identify market connectivity and accessibility and hinterland delineation. Betel leaf markets were mapped and the nearest market from leaf cultivating mouza and GP was identified, while market accessibility mapping was done in GIS domain. Market hierarchy has been analyzed using the Rank-Size Rule (Zipf, 1940). National and International spatial linkage were mapped based on the leaf destinations from the study area.
- Local and national economic benefits from the spatial linkages were analyzed through statistical techniques and graphical representation. International demand of betel leaf was analyzed through descriptive statistics and graphical representation and international demand forecast was done.

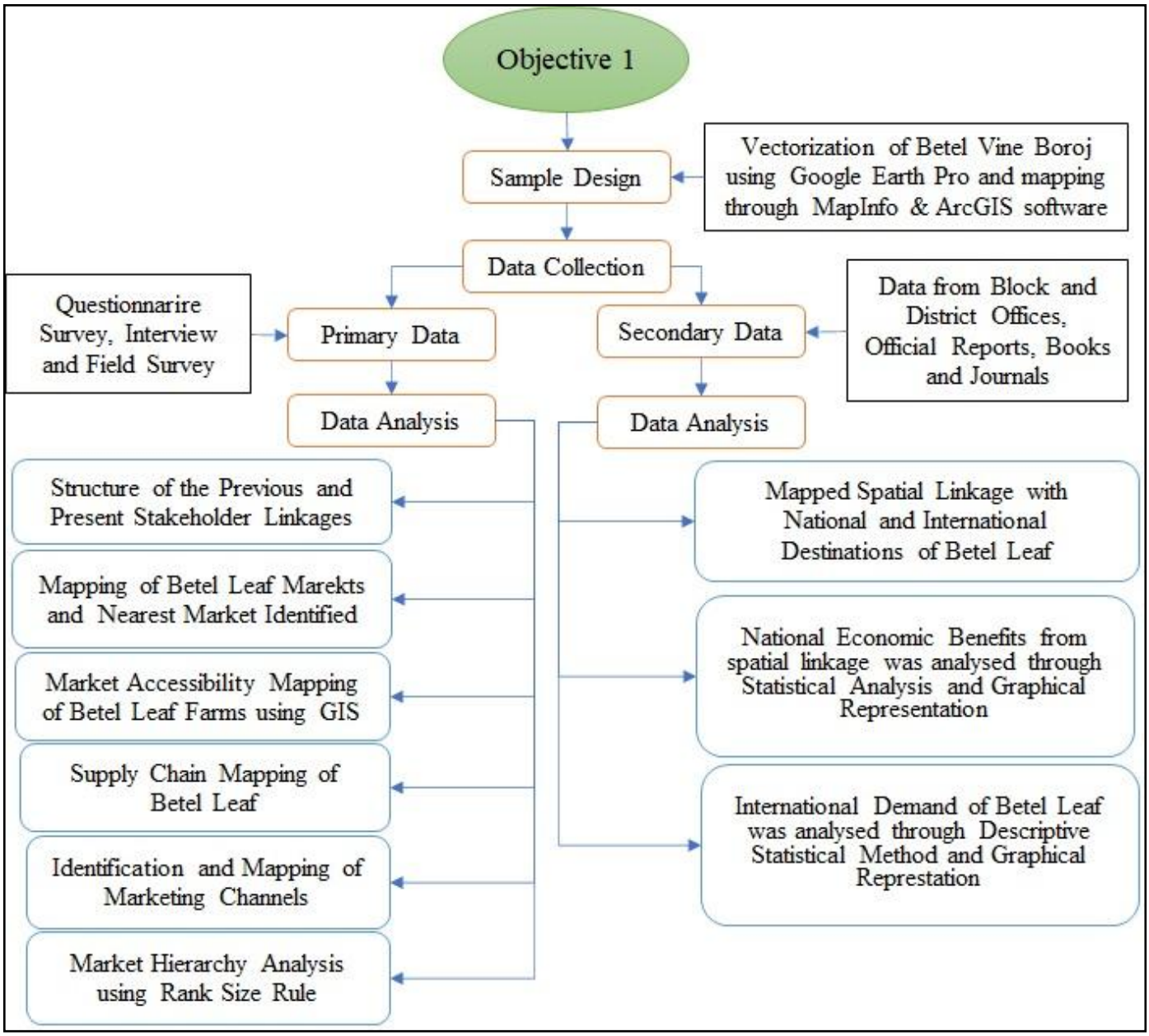

Objective 1
Sample Design
Vectorization of Betel Vine Boroj using Google Earth Pro and mapping through MapInfo & ArcGIS software
Data Collection
Questionnarire Survey, Interview and Field Survey
Primary Data
Secondary Data
Data from Block and District Offices, Official Reports, Books and Journals
Data Analysis
Data Analysis
Structure of the Previous and Present Stakeholder Linkages
Mapping of Betel Leaf Marekts and Nearest Market Identified
Market Accessibility Mapping of Betel Leaf Farms using GIS
Supply Chain Mapping of Betel Leaf
Identification and Mapping of Marketing Channels
Market Hierarchy Analysis using Rank Size Rule
Mapped Spatial Linkage with National and International Destinations of Betel Leaf
National Economic Benefits from spatial linkage was analysed through Statistical Analysis and Graphical Representation
International Demand of Betel Leaf was analysed through Descriptive Statistical Method and Graphical Represtation

Fig. 7: Methodological flowchart for the first objective

The linkage structure of betel leaf supply chain from producers to ultimate seller has changed through time. Earlier (about 50 years ago) the local traders (*Forial*) bought leaves from the farmers (Fig. 8) directly and farmers did not have to go to the market (*Mandi*). The local traders sold the purchased leaves at markets and the leaves were transported to different destinations through commission agents or traders and ultimately to different shops for consumers. However, now the betel leaf growers have to go to the market and sell directly to the *Aratdar* and commission agents, who then transport the leaves to different destinations (national and international markets). In this regard, robust supply chains are crucial, more so as the crop is readily perishable. The regular supply chain (Fig. 9) from farm to consumer that presently exists was ascertained.

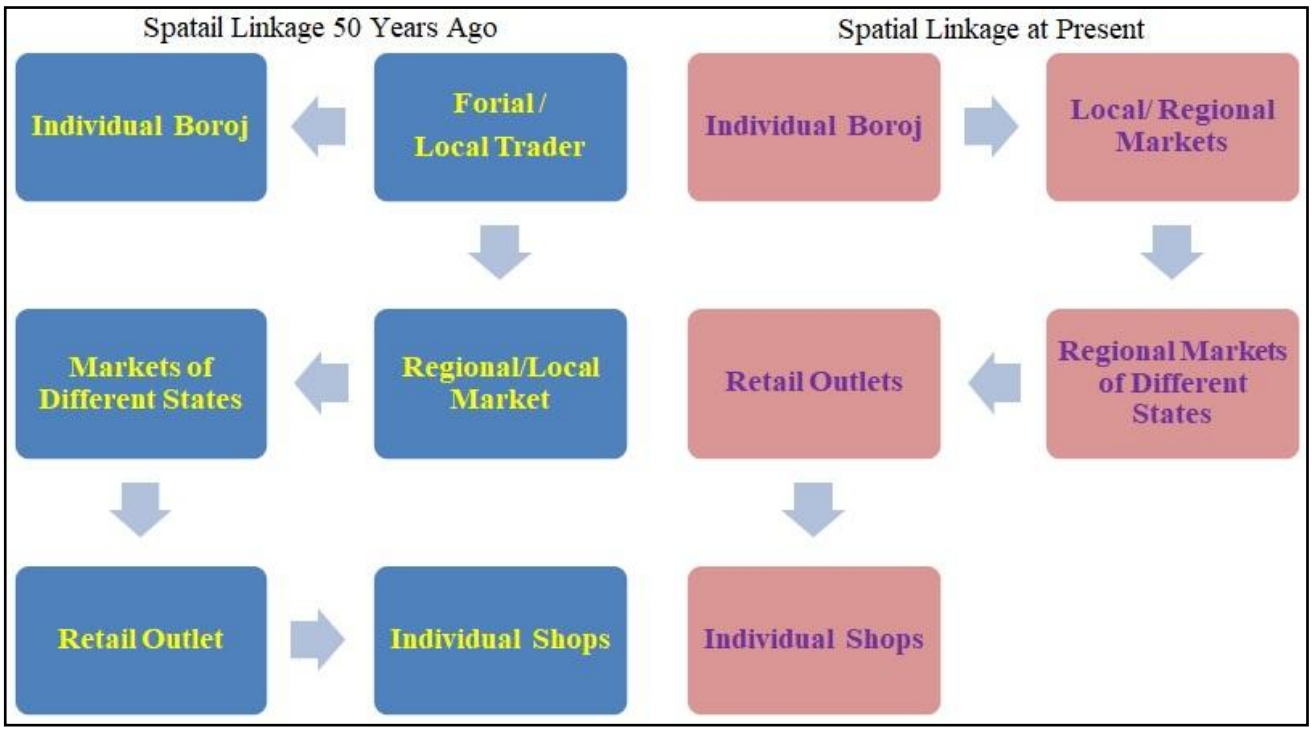


Fig. 8: Temporal changes in betel leaf supply chains and linkages

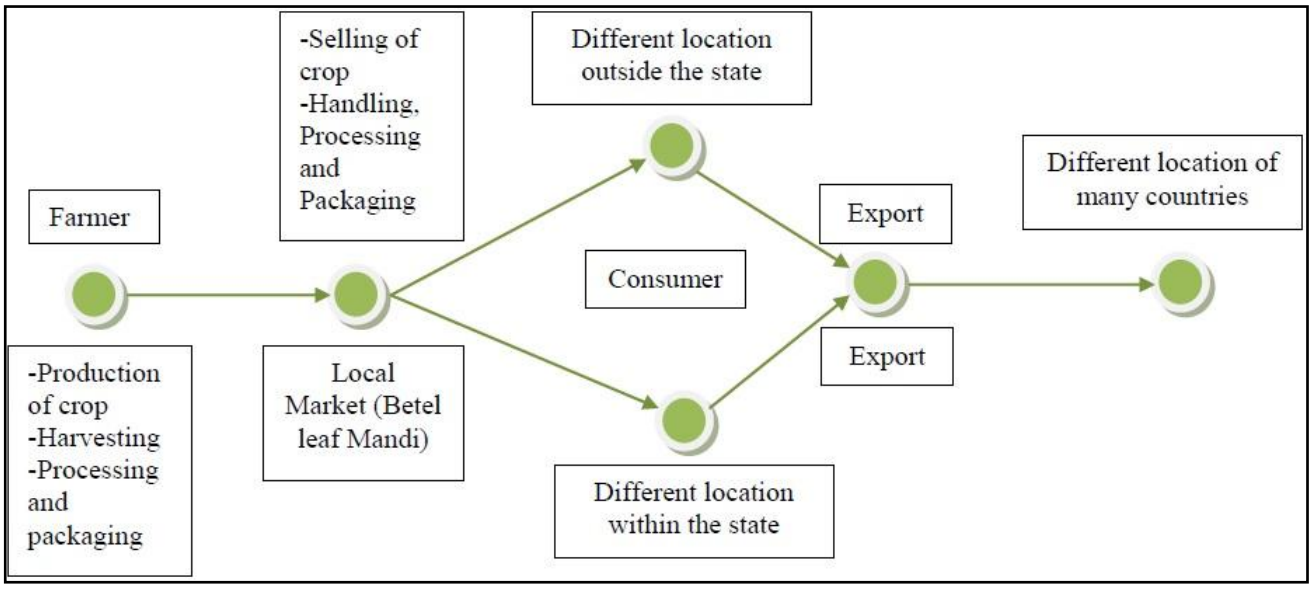


Fig. 9: Betel leaf supply chain

The marketing aspect affects every stakeholder of an agricultural/horticultural crop and it is an integral part of any policy for agricultural/horticultural development. Thus, it was necessary to identify the channels or pathways of selling the leaf and their respective efficiency (discussed in the ensuing chapter). Furthermore, it is important to analyze the efficiency of different channels, particularly for increasing the producer's share in the consumer's payment. Marketing channels are

the routes through which the crop moves from growers to consumer through various actors in the crop value chain. Six main marketing channels were identified (Fig. 10) in the study area-

1. Producer (Farmer) → *Aratdar* → Commission Agent (Primary Trader) → Secondary Trader → Retailer → Consumer
2. Producer (Farmer) → *Aratdar* → Regional Trader → Retailer → Consumer
3. Producer (Farmer) → *Aratdar* → Regional Trader → Consumer
4. Producer (Farmer) → Local Trader → Retailer → Consumer
5. Producer (Farmer) → Local Trader → Regional Trader → Retailer → Consumer
6. Producer (Farmer) → Local Trader → Regional Trader → Consumer

Among these channels, Channel-1 is predominant in the study area and most of the leaves produced are transported to various state, national and international markets through this channel.

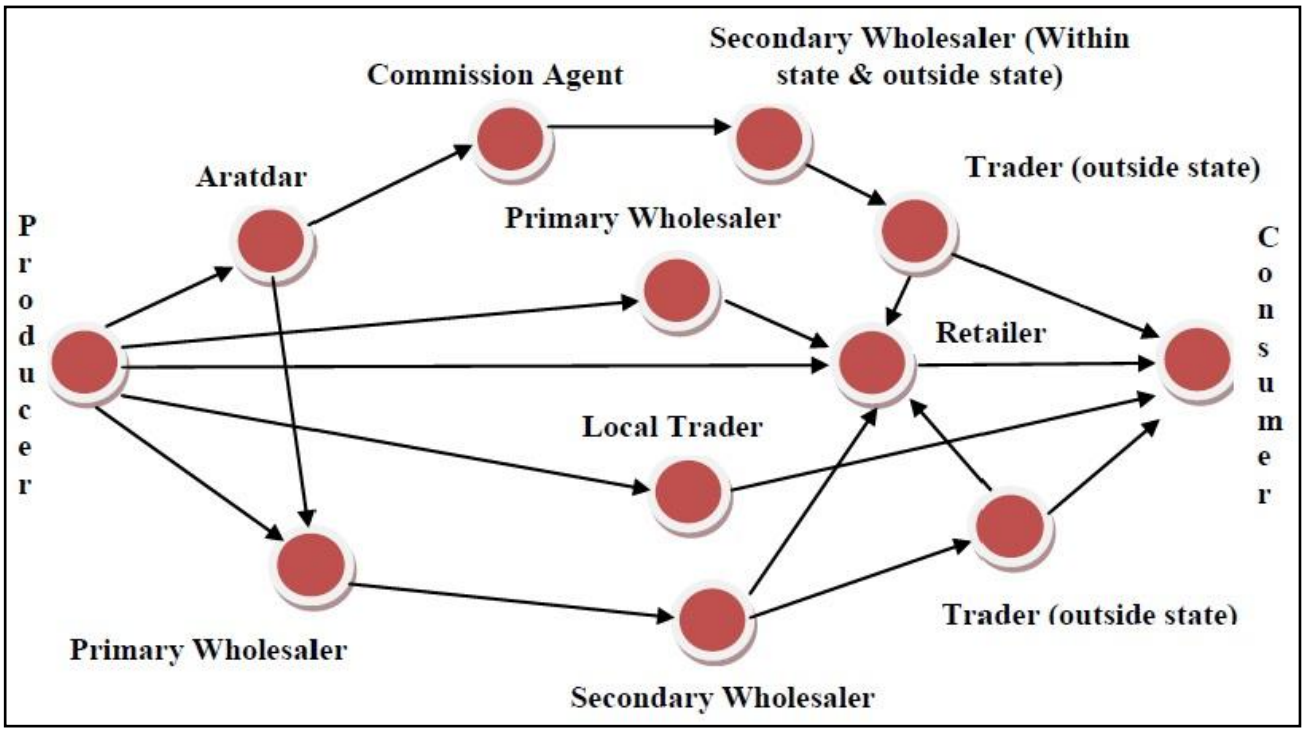


Fig. 10: Different marketing channels in the betel leaf supply chain

Transportation connectivity is an important factor in any crop's value chain due to its influence on the spatial linkage aspect. Better transportation and accessibility allows the produce to move quickly and cost-effectively to markets, reducing spoilage and requiring less storage/preservation facilities. Better accessibility is an extra advantage in the betel leaf value chain as it is a perishable crop. There are 16 main betel leaf market in Tamluk Sub-Division that are situated along the main high road (Fig. 11). All markets are well connected through different roads and thus farmers and traders can come here to sell their crop from neighbouring districts as well. The

market size varies in terms of amount of betel leaves sold per market day and the number of stakeholders involved in that particular market. Nimtouri Ram Sita Paan Samiti is the first ranked market in the study area (Table 2) and it receives 600 *mote*s (1 *mote* = 10000 betel leaves) per day. The Mecheda Ramkrishna Pann Market, Ratouri Janakalyan Paan Babasayi Samaiti, Kaktia Sri Krishna Paan Samiti, Uttar Narikeldah Ramkrishna Paan Babasayi-Chassi Unnayan Samiti markets are the 2nd, 3rd, 4th, 5th ranked markets, all of which receive at least 250 *mote*s per market day.

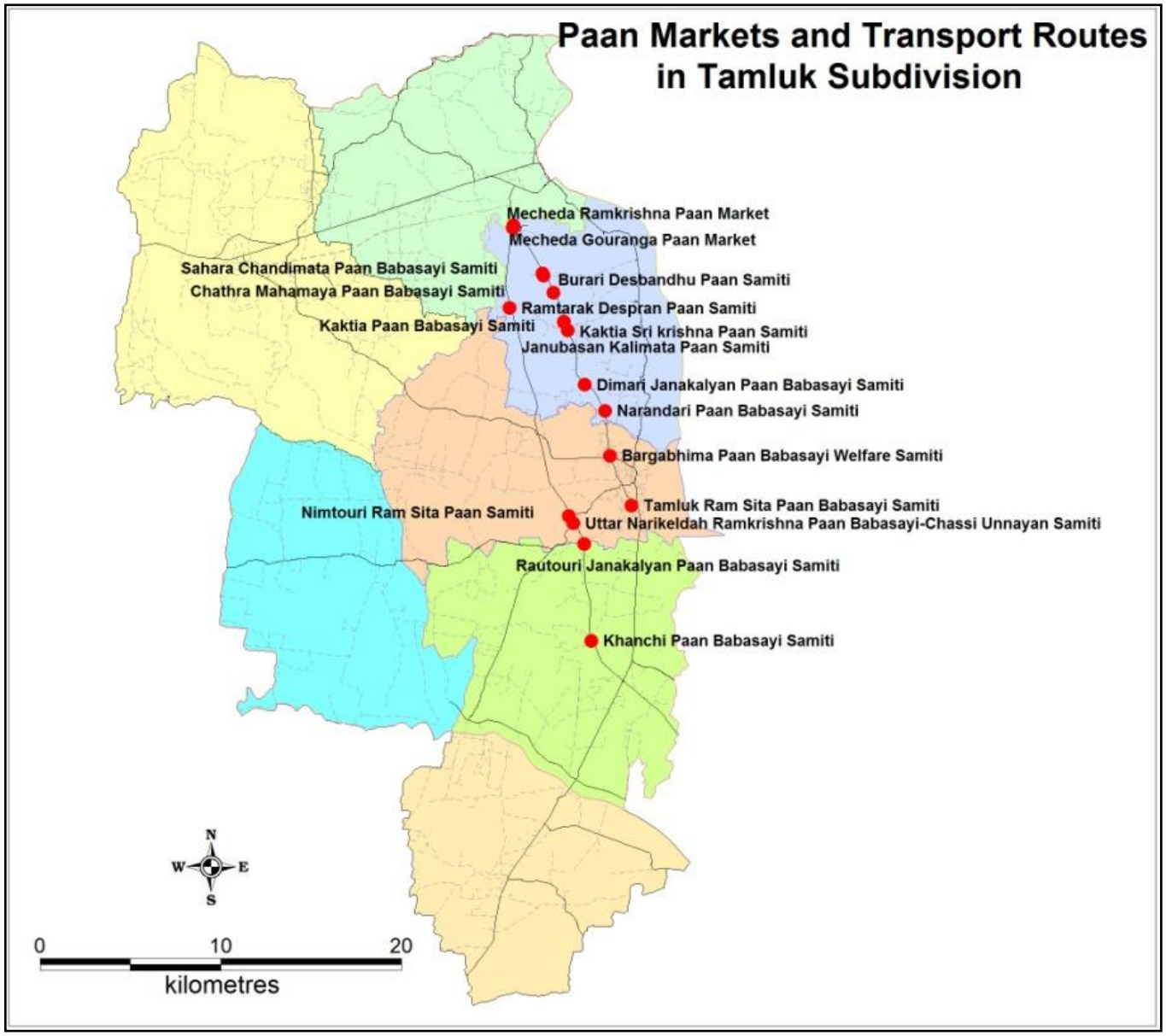


Fig. 11: Betel leaf markets and transport connectivity

The transport connectivity from these five big markets was mapped to examine their accessibility to the various betel leaf producing mouzas and GPs (Fig. 12). The international destinations of betel leaves from the study area was ascertained (Fig. 13) to gauge its demand and the importance of this region as its cultivation and marketing centre.

Table 2: Rank Size distribution of betel leaf markets based on *motes*

Market Name	Rank	Quantity arrival (*Motes*)	1/r	Estimated arrival
Nimtouri Ram Sita Paan Samiti	1	600	1.00	1092.96
Mecheda Ramkrishna Paan Market	2	500	0.50	546.48
Rautouri Janakalyan Paan Babasayi Samiti	3	450	0.33	364.32
Kaktia Sri Krishna Paan Samiti	4	350	0.25	273.24
Uttar Narikeldah Ramkrishna Paan Babasayi-Chassi Unnayan Samiti	5	250	0.20	218.59
Ramtarak Despran Paan Samiti	6	210	0.17	182.16
Bargabhima Paan Babasayi Welfare Samiti	7	200	0.14	156.14
Burari Desbandhu Paan Samiti	8	190	0.13	136.62
Dimari Janakalyan Paan Babasayi Samiti	9	180	0.11	121.44
Chathra Mahamaya Paan Babasayi Samiti	10	175	0.10	109.30
Tamluk Ram Sita Paan Babasayi Samiti	11	150	0.09	99.36
Narandari Paan Babasayi Samiti	12	120	0.08	91.08
Sahara Chandimata Paan Babasayi Samiti	13	110	0.08	84.07
Mecheda Gouranga Paan Market	14	100	0.07	78.07
Khanchi Paan Babasayi Samiti	15	80	0.07	72.86
Janubasan Kalimata Paan Samiti	16	30	0.06	68.31
Total		**3695**	**3.38**	

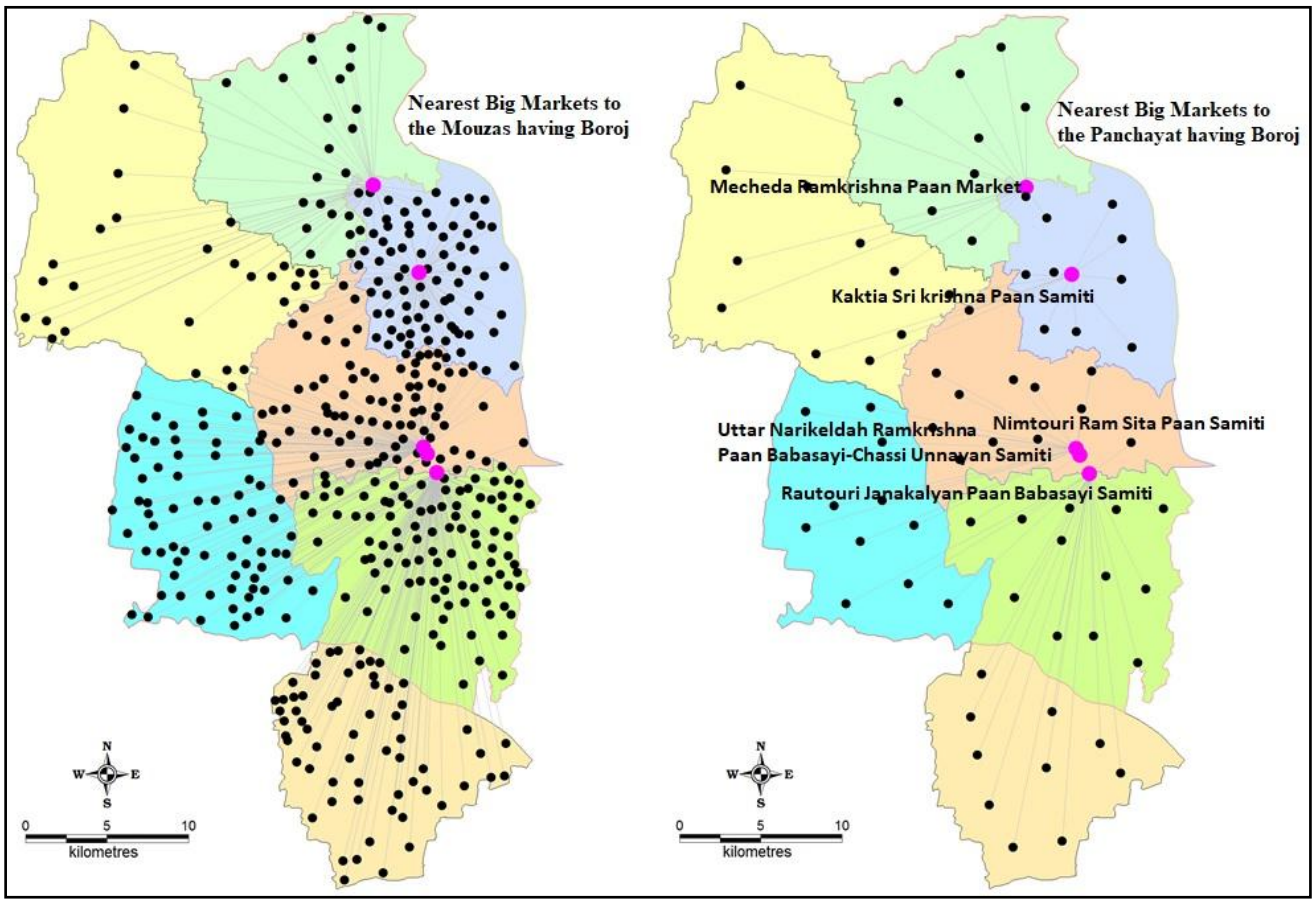


Fig. 12: Connectivity between big markets and betel leaf growing areas

Exports of betel leaf to Sri Lanka, Bangladesh, Pakistan, Afghanistan, Australia, Canada, France, Germany, Hong Kong, Kenya, Nepal, United Kingdom, UAE, Saudi Arabia, Oman, Qatar, USA, Yemen and the EU countries generates substantial revenue for the country. While the amount of exported betel leaf and its annual worth differs from year to year (Table 3), a huge quantity is exported from India, foremost among which is from Tamluk Sub-Division.

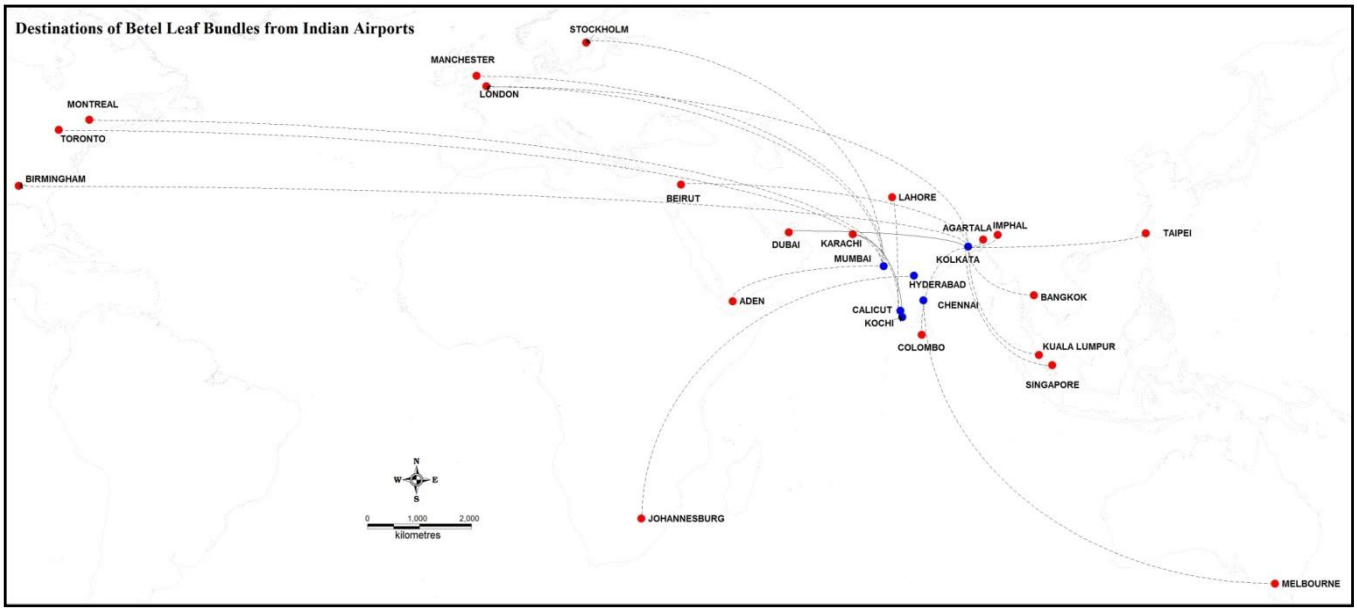


Fig. 13: Countries where betel leaf is exported

Table 3: Betel leaf export from India and its annual worth

Year	Amount Exported (MT)	Worth (Crores)	Worth (USD Millions)
2017-18	8140.3	26.8	4.15
2018-19	13195.43	46.75	6.74
2019-20	10386.52	37.6	5.22
2020-21	6159.39	26.18	3.55

Source: Agricultural and Processed Food Products Export Development Authority (APEDA)

Thus, disruption in the betel leaf value chain can affect the regional economy and the different stakeholders. Government participation and norms are thus required to safeguard the betel leaf value chain for assuring profit to farmers from the different marketing channels. Moreover, apart from the income by exporting betel leaves to different countries, these linkages also play a role in local to national transportation of the leaves. The Railways earn substantial monthly tariff/freight and make it possible to transport the crop cost-effectively to different parts of the country. This income fluctuates from year to year and month to month (Fig. 14) but maximum earnings occur between March and October. The Railways also earns a substantial amount monthly by transporting leaves from Mecheda and Panskura stations to different local stations like Howrah and Kharagpur.

However, here too there are issues related to insufficient storage and the wagon lease system at times forces traders to transport the leaves by truck, at a higher cost. The Railways' Lease System started in 2008, which has adversely affected its own earnings, as road transport is now more preferred. As a result, betel leaf transport from Tamluk Railway Station to Chennai has stopped after March 2018.

Thus, it is clearly seen that spatial linkages play an important role in the betel leaf value chain and influences the profit margins of the stakeholders. The government also generates much revenue from this value chain. As any disruption may lead to marked losses for all the stakeholders, it is thus paramount that the linkages, norms and infrastructure of this chain be made more robust.

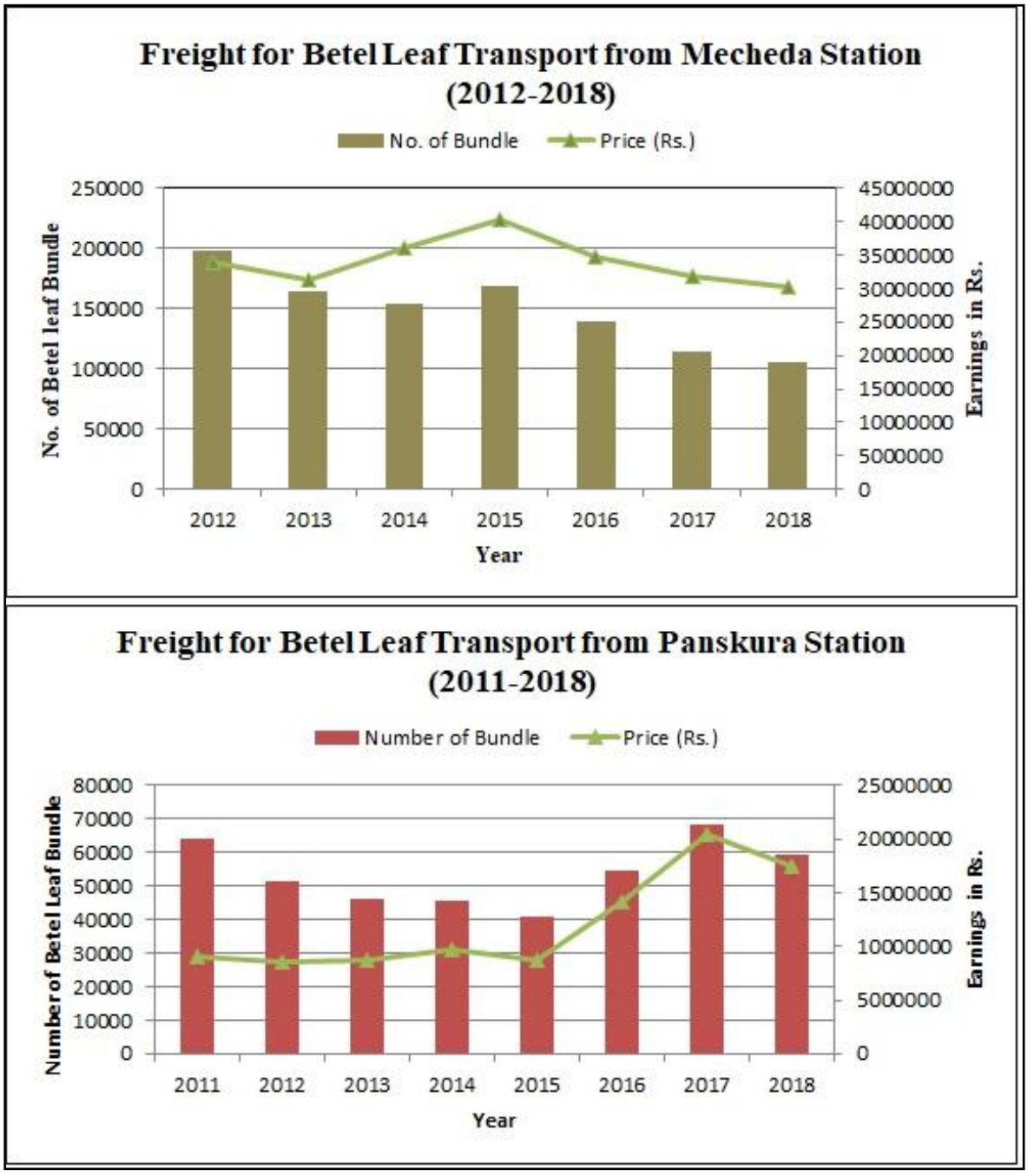


Fig. 14: Railways' income from betel leaf transportation

Chapter- V **Suitability analysis of betel leaf cultivation**

The second objective is divided into Chapters V and VI and the methods used (Fig. 15) are-

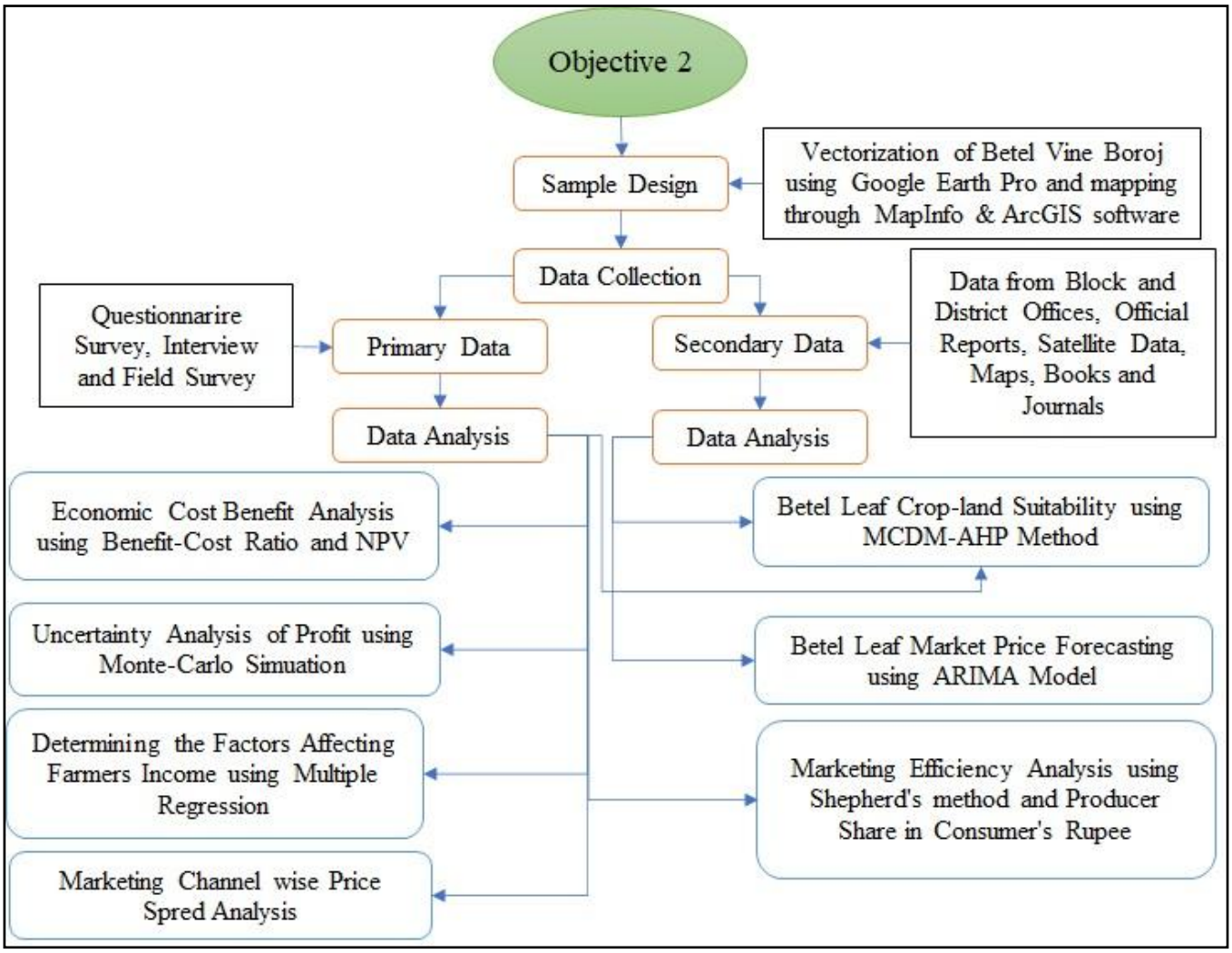

Objective 2
Sample Design
Vectorization of Betel Vine Boroj using Google Earth Pro and mapping through MapInfo & ArcGIS software
Data Collection
Questionnarire Survey, Interview and Field Survey
Primary Data
Secondary Data
Data from Block and District Offices, Official Reports, Satellite Data, Maps, Books and Journals
Data Analysis
Data Analysis
Economic Cost Benefit Analysis using Benefit-Cost Ratio and NPV
Betel Leaf Crop-land Suitability using MCDM-AHP Method
Uncertainty Analysis of Profit using Monte-Carlo Simuation
Betel Leaf Market Price Forecasting using ARIMA Model
Determining the Factors Affecting Farmers Income using Multiple Regression
Marketing Efficiency Analysis using Shepherd's method and Producer Share in Consumer's Rupee
Marketing Channel wise Price Spred Analysis

Fig. 15: Methods flowchart for the second objective

Crop-specific land suitability analysis can better support a region's agricultural base and enhance its resource utilization efficiency. The Analytical Hierarchic Process-based Multi-Criteria Decision-Making (AHP-MCDM) approach along with geospatial inputs/methods was employed to assess land suitability for betel leaf cultivation in the study area (Fig. 16). Seventeen individual parameters were grouped into five categories- physiographic, land use and land cover, climatic, pedologic and infrastructural- were used. A 500×500 meter grid overlay elicited location specific combinations of the different land suitability classes and the presence/absence of waterbodies required for irrigation. It also ascertained the locational aptness of current betel leaf plots, while identifying expansion sites for this crop in grids having more than 40% of suitable lands with available water resources. The respective databases for the above parameters were prepared from

different primary and secondary sources. Overlay analysis was performed via the weighted sum method to generate the initial suitability map. From this, the suitability of presently available lands for betel leaf cultivation and possible future expansion sites was gauged by extracting the existent horticultural plots and the built-up LULC class. The obtained Consistency Ratio value for the AHP-MCDM analysis was 0.048, quite lower than the maximum allowable value of 0.1. Thus, the ascertained weights for each criterion were valid as per the required threshold values (Saaty, 2008).

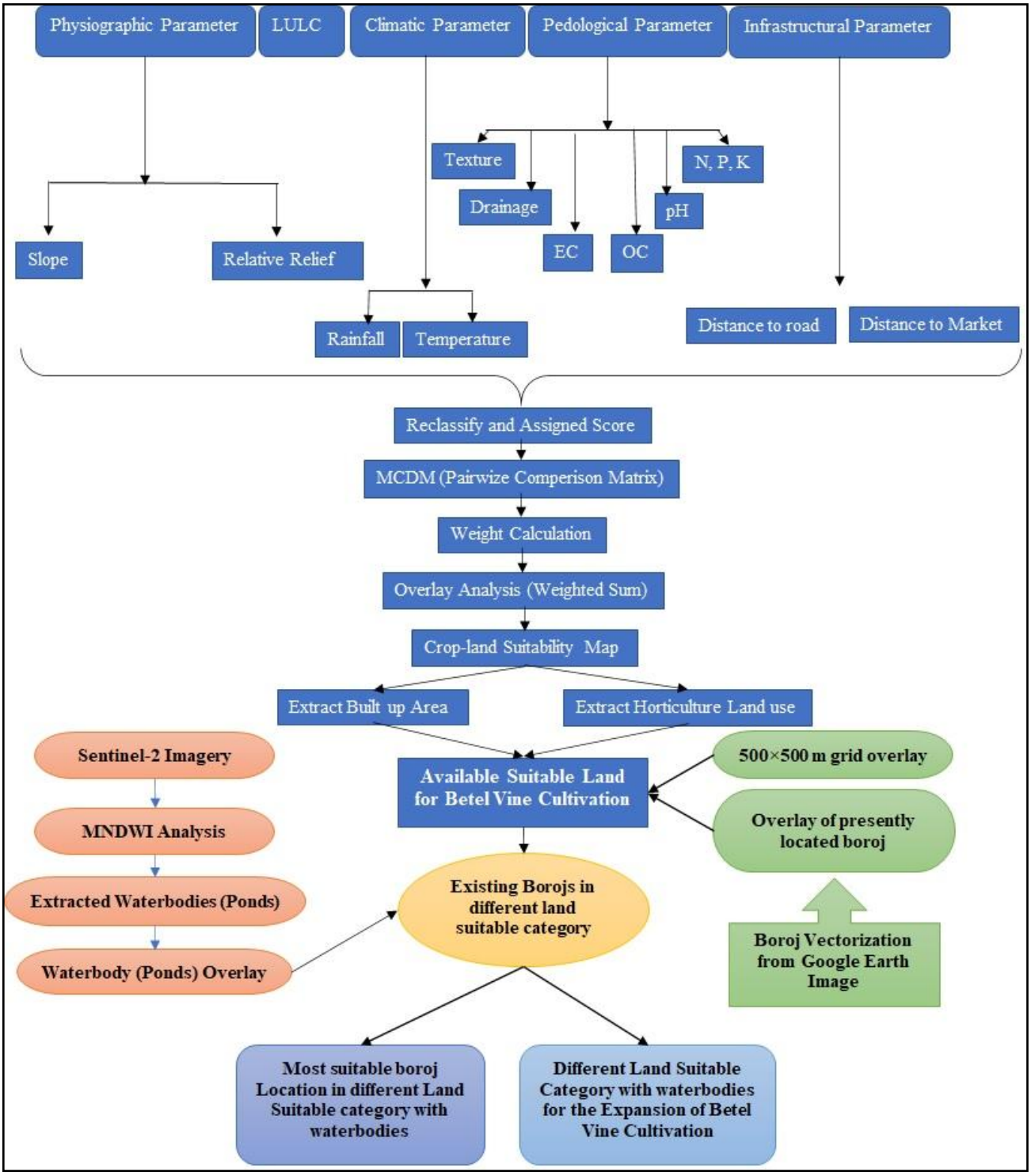


Fig. 16: Flowchart for betel leaf cropland and existing *Boroj* site suitability analysis

The seventeen parameters selected were mapped and classified into their respective sub-criteria and each sub-class was given a score from 1 to 10 (cf. Widiatmaka, 2016; Bandyopadhyay et al., 2009), according to their importance in betel leaf production based on expert (local agronomists') opinions and farmer inputs. All layers were combined via the weighted sum method through overlay analysis. The obtained land suitability map had five classes to denote highly/moderately/marginally suitable tracts for betel leaf cultivation and those that were permanently not suitable. The existing horticultural areas, waterbodies and built-up tracts were overlain on the above map to demarcate more specifically the site suitability of locales wherein betel leaf acreage can be feasibly extended.

Table 4: Suitability of land for betel leaf cultivation in Tamluk Sub-Division

Suitability Classes	Suitable land		Suitable land excluding horticulture land		Suitable & Available land excluding horticulture land use & built-up area	
	ha	%	ha	%	ha	%
S1 (Highly Suitable)	8550.356	8.060	7846.83	7.397	7279.932	6.862
S2 (Moderately Suitable)	36540.05	34.440	34900.622	32.899	31978.180	30.145
S3 (Marginally Suitable)	16942.32	15.970	16471.662	15.527	11949.212	11.264
N1 (Not Suitable)	40877.65	38.530	40377.265	38.062	11586.607	10.922
N2 (Permanently Not Suitable)	3172.433	2.990	3156.882	2.976	453.879	0.428

The number of waterbodies present in each grid was enumerated as regular availability of irrigation is crucial for a good betel leaf harvest. Once the above grid-wise land suitability class percentages and *Boroj*/ponds counts were ascertained, the respective layers were superimposed to examine the most likely spots where new betel leaf plantations can be established, while also showcasing if present *Boroj* locations were in the most suitable tracts or not.

The resultant crop-land suitability (CLS) map (Fig. 17a) shows that overall, 58.47% of the lands available are suitable for betel leaf cultivation. Within this, 8550.36 ha (8.06%) lands are highly suitable, 36540.05 ha (34.44%) are moderately suitable, 16942.32 ha (15.97%) are marginally suitable (i.e. can be better utilized if ambient factors become more favourable). Alternately, 40877.65 ha (38.53%) are presently not suitable due to various restrictive factors and 3172.43 ha (2.99%) of lands are permanently unsuitable for any agricultural practices. A second suitability map was generated (Fig. 17b) by overlaying the already present horticultural areas within Tamluk Sub-Division within the initial suitability map generated above, which reveals whether the best possible zones are already being utilized for this purpose. Results (Table 4) show that 1639.43 ha (49.24%) of the present horticulture land lies within the moderately suitable category, 703.53 ha (21.13%) are under the highly suitable class, 500.38 ha (15.029%) are under the not suitable class, 470.65 ha (14.14%) are under the marginally suitable class while 15.55 ha (0.476%) of lands are under the

permanently not suitable class. Thus most sites/extents (almost 50%) where horticulture (i.e. mostly betel vine) is presently practiced are only moderately suitable for betel leaf cultivation. This can be an underlying cause why the reported decline in acreage has occurred in this crop's cultivation.

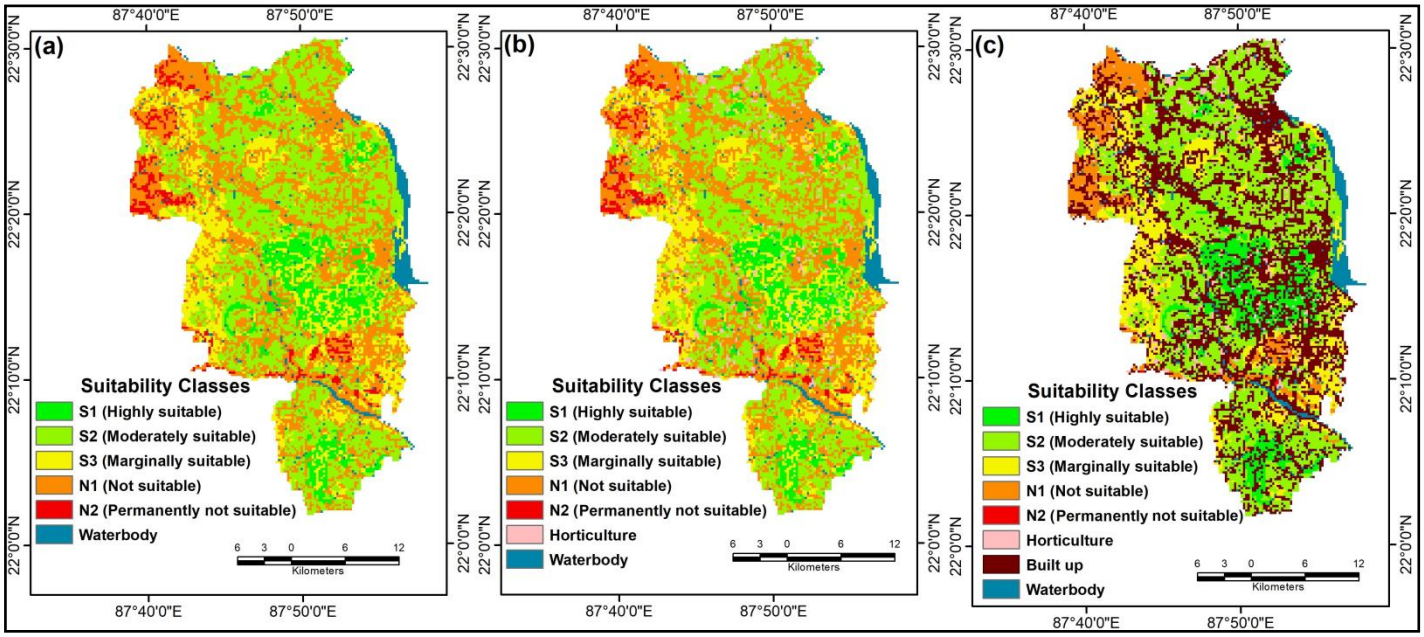


Fig. 17: Betel leaf land suitability maps of the study area, based on different extraction criteria

The final output (Figure 17c), obtained after removing built-up areas where horticulture is unfeasible, shows that 7279.93 ha (6.86%) are highly suitable for betel vine cultivation, 31978.18 ha (30.15%) are moderately suitable, 11949.21 ha (11.26%) are marginally suitable, 11586.61 ha (10.92%) are not suitable and 453.879 ha (0.43%) are permanently not suitable.

The locations of the highly suitable category lands (S1-type) are mainly in Nandakumar, Tamluk, Sahid Matangini and Moyna Blocks (Fig. 18a), with up to 80 *Boroj*s present in the grids that have a considerable percentage of the S1-type land category, especially in Nandakumar. However, most grids in Moyna contain 40-80 *Boroj*s while those in Tamluk and Sahid Matangini blocks have just 20-40 *Boroj*s. Thus some grids that have a very high percentage of S1-type lands, still report a much lower number of *Boroj*s. A possible reason could be the lack of proper irrigation facilities and this is partly borne out by these grids also reporting lower pond numbers (Fig. 18a).

The coverage of S2-type lands is most widespread, especially in Sahid Matangini and Moyna blocks. Grids that contain moderate to high proportion of S2 lands also report high number of *Boroj*s, especially in Moyna, where some grids have as many as 120 *Boroj*s (Fig. 18b). However, the same grids in Sahid Matangini report much lower *Boroj* numbers and this is again linked to less ponds present therein (Fig. 19b). Marginally suitable lands (S3-type) that contain *Boroj*s at present are mostly in Nandakumar, Moyna and Tamluk, where on average less *Boroj*s (up to 40 per grid) are present (Fig. 18c). However, some grids in Nandakumar do contain many *Boroj*s (more than 100)

where the S3-type coverage is higher as more ponds are present in these grids (Fig. 19c). What Table 5 thus shows is that water availability can support higher than average *Boroj* numbers on less suitable lands.

Table 5: Grid-wise assessment of land suitability and *Boroj* and pond counts

Land Suitability class	***Boroj* currently present within the grid**						**No *Boroj* at present situated within the grid**			
	Overall across all grids where any *Boroj* are present (N=1868)			**Only grids where S1, S2 or S3 types are actually present (N=544 for S1, N=1273 for S2 and N=811 for S3)**			**Overall across all grids where no *Boroj* are currently present (N=2759)**		**Only grids where S1, S2 or S3 types are actually present (N=325 for S1, N=1716 for S2 and N=977 for S3)**	
	Mean coverage % in grid	**Mean *Boroj* count**	**Mean Pond count**	**Mean coverage % in grid**	**Mean *Boroj* count**	**Mean Pond count**	**Mean coverage % in grid**	**Mean Pond count**	**Mean coverage % in grid**	**Mean Pond count**
S1	11.62	21.79	4.25	39.90	26.36	4.23	4.54	2.49	38.53	3.17
S2	30.45			44.68	20.22	4.24	32.21		51.79	2.86
S3	15.51			35.73	23.51	4.67	14.36		40.55	2.81

Expansion possibilities for betel leaf plots: Those grids that have a considerable proportion of the highly suitable (S1-type) land category along with numerous ponds but presently do not have any *Boroj*s, are ideal for this purpose. The mapping results show three zones that meet the above stated requirements- in the western part of Kolaghat Block, the western and central parts of Tamluk Block and the central part of Chandipur Block (Fig. 20a). Among these, the best placed are locations in western Tamluk, from where numerous grids report above 70% coverage of S1-type lands and 1-20 ponds. Grids having more than 80% land under the moderately suitable (S2-type) category and a good number of ponds are mostly in Kolaghat, Panskura and Chandipur and partly in Moyna, Sahid Matangini and Tamluk (Fig. 20b). Grids having more than 80% marginally suitable (S3-type) lands and available water sources but lacking any *Boroj*s are mainly along the western margin in Panskura, Moyna and Chandipur and partly in the Kolaghat, Sahid Matangini and Nandakumar (Fig. 20c).

In terms of the different land suitability class combinations, from analysis of present *Boroj* locations, the most favourable grids had some combination of the S1-S3 (more preferred) or S1-S2 types (Fig. 21a), along with some ponds (Fig. 21b). Interestingly, some grids in the western Nandakumar Block do not have any suitable land but can support *Boroj*s simply based on the water availability. The S1-S2 combination is present in 157 grids, albeit with lower pond numbers and this is thus comparatively less viable for new betel vine plots (Fig. 21c). The most ideal locations for creating new *Boroj*s (in grids lacking them) can be in the central Chandipur, northern Moyna and eastern Panskura, where both the S1-S3/S1-S2 suitability type combinations together with ponds are available. The other possible location is in the western and northern part of Kolaghat Block, where the S2-type suitability class is in combination with an adequate number of ponds.

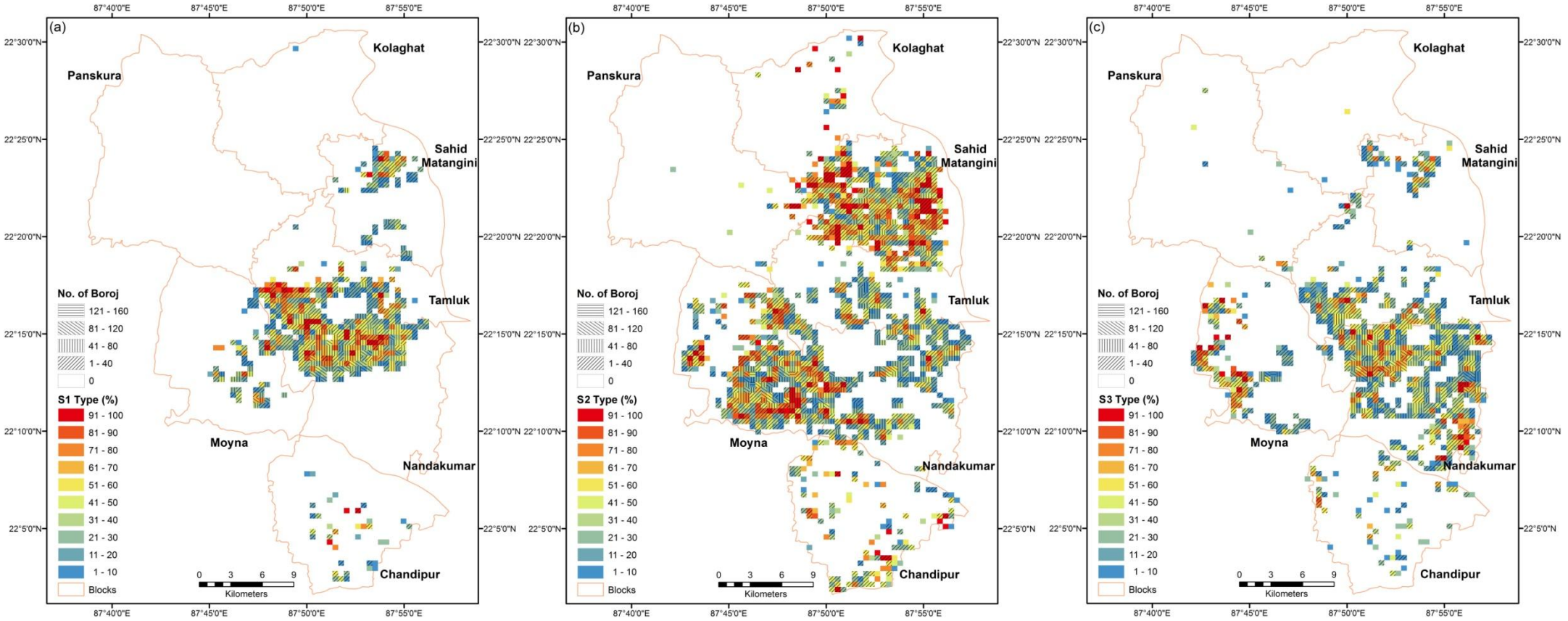


Fig. 18: Grid-wise *Boroj* counts and proportion of land suitability class- (a) S1-type, (b) S2-type, and (c) S3-type

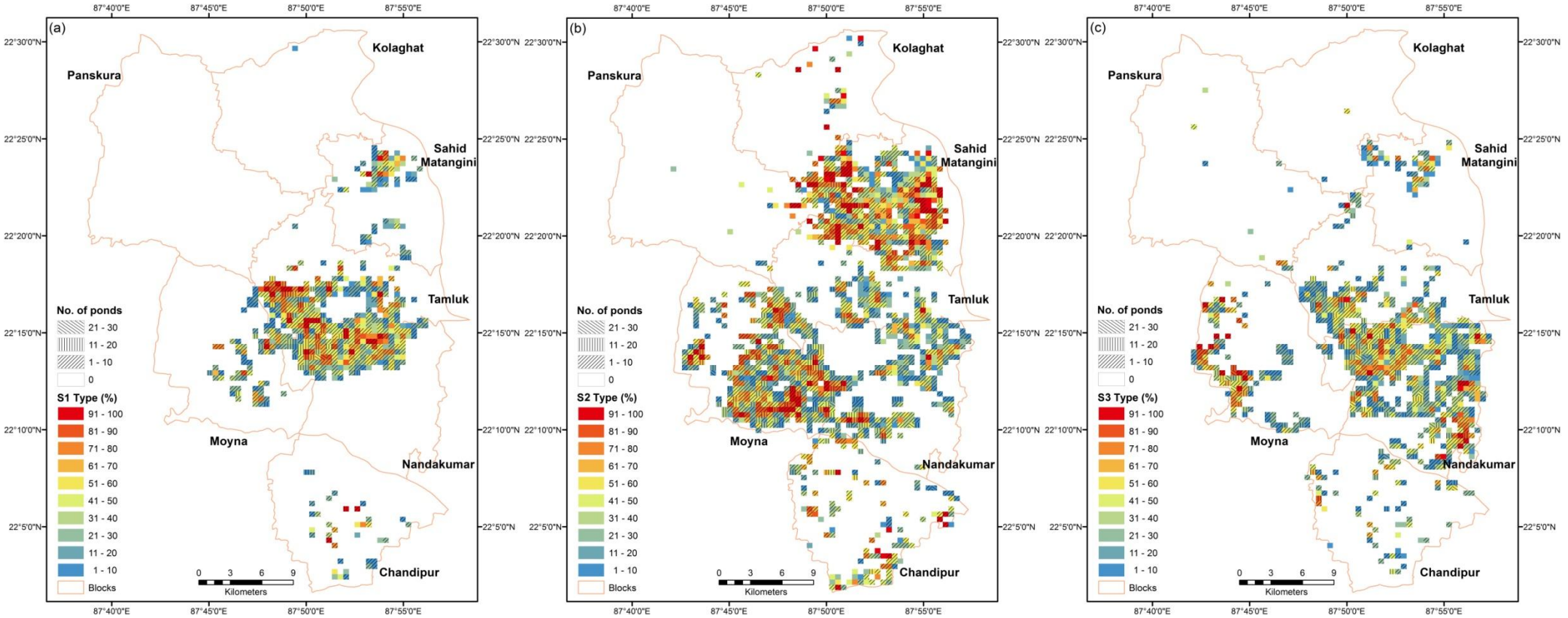


Fig. 19: Grid-wise pond counts and proportion of land suitability classes in grids that presently have *Borojs*- (a) S1-type, (b) S2-type, and (c) S3-type

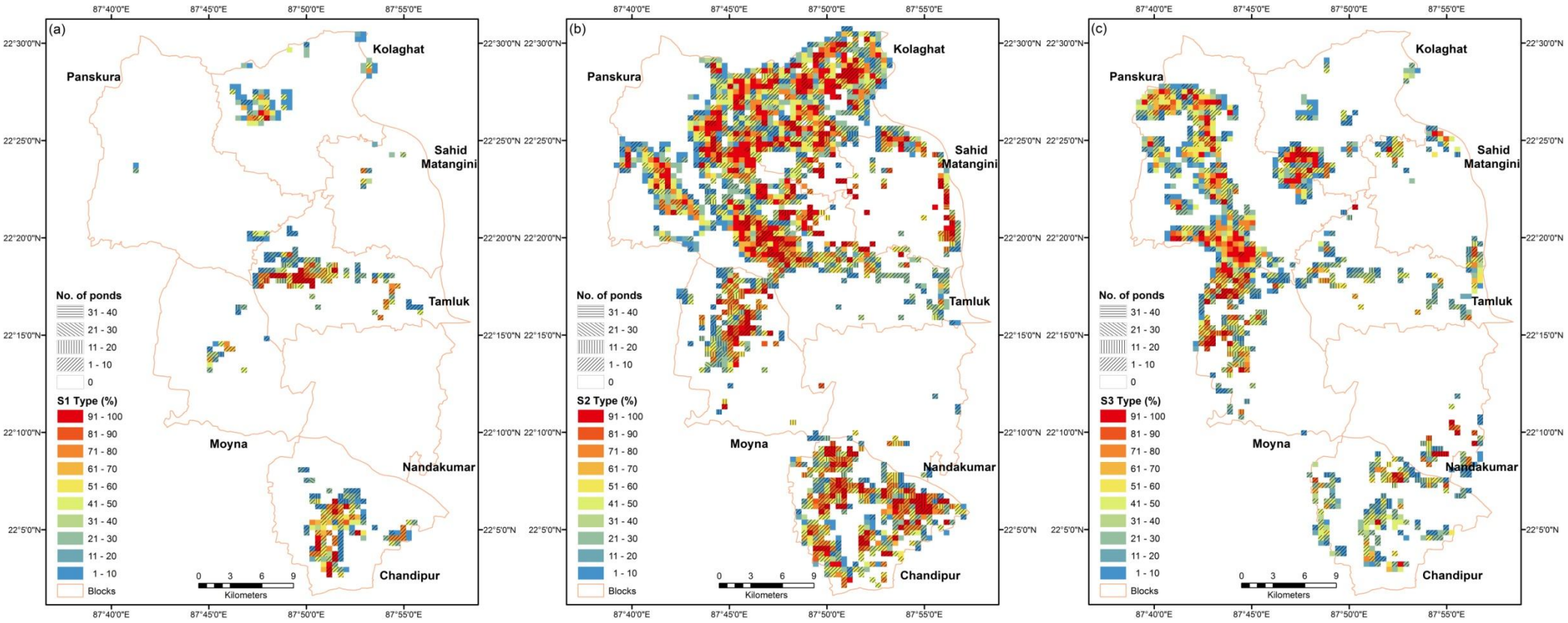


Fig. 20: Grid-wise pond counts and proportion of land suitability class in grids that do not have any *Boroj* at present- (a) S1-type, (b) S2-type, and (c) S3-type

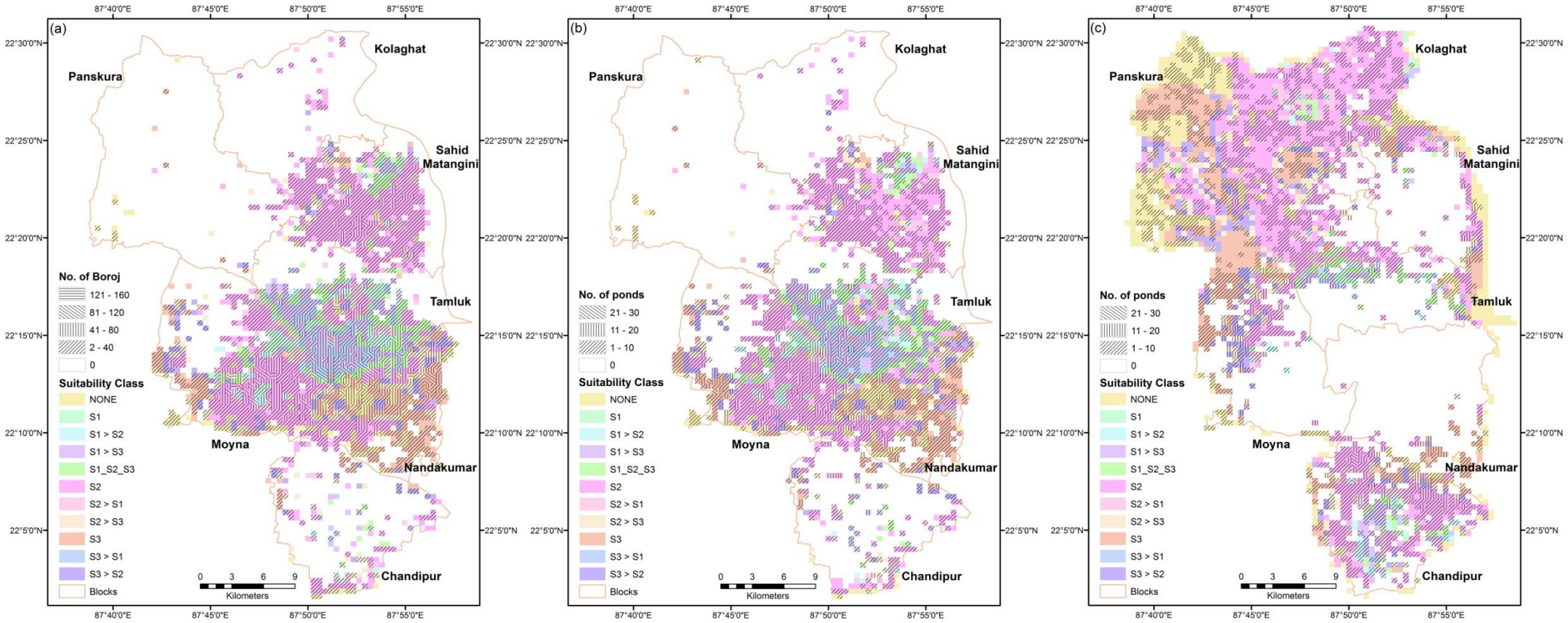


Fig. 21: Grid-wise land suitability class combinations- (a) With existing betel vine *Boroj* stands, (b) Pond numbers in grids that have *Boroj*s at present, and (c) Pond numbers in grids that do not have *Boroj*s at present

Chapter – VI **Agro-economic viability of betel leaf cultivation and marketing**

The methods followed to meet the stated objectives were as follows:

- Economic cost-benefit analysis in terms of Gross Margin, Net Return and Benefit-Cost Ratio.

  Gross Margin = Gross Return -Variable Cost

  Net Return = Gross Return - Total Cost

  Cost-Benefit analysis was carried out using the Net Present Value (NPV) concept to evaluate the viability of betel leaf cultivation in the study area using the following equation:

$$NPV=\sum_{t=0}^{n} \frac{c_t}{(1+\dot{r})^t}$$

where, C_t = Cash flow at that point of time, t = Time of cash flow and r is the discount rate.

- Uncertainty or risk analysis to profit of the farmers was computed using Monte-Carlo Simulation and the expected value of NPV, E(NPV) to capture the future uncertainty, as:

$$E(NPV)=\sum_{x\in X} NPV(X)P(X)$$

where, x is a vector representing a scenario that is to be analyzed, each component in x represents the state of random variable and X is the space of states. P(X) = probability of the x scenarios and NPV(X) is the obtained result to the NPV in the analyzed x scenarios.

- Multiple Regression was carried out to ascertain the contribution of relevant factors in betel leaf income, as:

$$Y=ax_1^{b1}\ x_2^{b2} x_3^{b3} x_4^{b4} \dots x_n^{bn}$$

where, Y= Annual returns from betel leaf production; a= Constant of the function; x= Inputs, and b= regression coefficients of the respective variables.

- Marketing Efficiency and Price Spread analysis for identifying efficiency of marketing system was done using Shepherd's Approach and Producer Share in Consumer's Rupee, as:

$$\text{Producer share to consumer 's Rupee} = PNP/RP\ \frac{PNP}{RP} \times 100$$

where, PNP= Producer Net Income and RP is the Retailer Price.

$$\text{Shepherd's equation, MEI} = \frac{V}{I} \times 100$$

where, MEI = Index of Marketing Efficiency, V= Value of goods sold (consumer's rupee), I= Total marketing costs and marketing margin.

- The ARIMA model was used on the time series data of price of betel leaf to predict the future prices based on the historic dataset. It has two components, AR and MA, as follows:

Autoregressive process of order (p) is,

$$Yt = Ø_0 + Ø_1\ Y_{t-1} + Ø_2\ Y_{t-2} + \dots\dots\dots\dots + Ø_p\ Y_{t-p} + e_t$$

where, Yt is the response variable at time t, such that-

Y_{t-1}, Y_{t-2} ..... Y_{t-p} is the respective variables at different time with lags, and

$Ø_1$, $Ø_2$, ... $Ø_p$ are the coefficients, and e_t is the error factor.

Moving Average process of order (q) is,

$$Yt = € _t + €_t + δ1\ €_{t-1} + \ldots\ldots + δ_q\ €_{t-q} + e_t$$

where, $€_t$ is the constant mean of the series, $δ_1 \ldots.\ δ_q$ is the coefficients of the estimated error term and e_t is the error term.

Combining these two, the general form of ARIMA is as-

$$Yt = Ø_0 + Ø_1\ Y_{t-1} + Ø_2\ Y_{t-2} + \ldots + Ø_p\ Y_{t-p} + e_t + δ1\ €_{t-1} + \ldots\ldots + δ_q\ €_{t-q} + e_t$$

Results

Costs and Returns from betel leaf cultivation

Table 6 shows the expense details per 5 decimal land of betel leaf cultivation for the different leaf types. It was found that the total cost (cost C2) of *Bangla* leaf cultivation in the 1st year of *Boroj* establishment is *Rs. 45649.32 per 5 decimal and Rs. 37225.29 per 5 decimal (2nd to 4th year), Rs. 37253.28 per 5 decimal (5th to 7th year), Rs. 37259.56 per 5 decimal (8th to 10th year), respectively***.** In case of *Mitha* leaf, the total cost of cultivation for 5 decimals is *Rs. 37259.56 per 5 decimal, Rs. 44009.98 per 5 decimal, Rs. 44038.29 per 5 decimal, and Rs. 44038.29 per 5 decimal in the respective years. Sanchi* leaf production cost for 5 decimals land is *Rs. 49354.52 per 5 decimal, Rs. 41889.61 per 5 decimal, Rs. 41889.70 per 5 decimal and Rs. 41889.70 per 5 decimal,* for these years.

The net return over total cost is highest for *Mitha* leaf cultivation (*Rs. 63414.88 per 5 decimal in the 5th to 7th year*). While the net return from the other two betel leaf varieties is lower than *Mitha,* for all the types the highest returns are obtained by farmers during the 5th to 7th years after *Boroj* establishment. This shows the usual gestation and investment period required to profit well through this crop's cultivation. The benefit cost ratio over the cost A1, B2, C1 and C2 was obtained highest in 2.95, 2.83, 2.53, 2.44 for *Mitha* leaf and respectively in *Sanchi* and *Bangla* leaf cultivation. Therefore, it can be said that the cultivation of the *Mitha* variety of betel leaf is more profitable than the other types and particularly in case of the *Bangla* variety, farmers obtain quite less profits in ensuing years after *Boroj* establishment.

Table 6: Cost Structure, Return and Benefit-Cost Ratio of betel leaf cultivation in the study area

		Cost of Betel Vine Cultivation (Rs. / 5 decimal)											
		Bangla				***Mitha***				***Sanchi***			
Sl. No.	**Item**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 year**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 Year**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 Year**
1	*Boroj* Material	7913.52	4609.30	4598.40	4598.40	8049.53	4628.04	4628.04	4628.04	8129.36	5080.04	5080.04	5080.04
2	Sapling	2818.46				9510.18				2972.02			
3	Soil	3098.03	3290.34	3290.34	3290.34	5050.50	5050.50	5050.50	5050.50	2380.95	2380.95	2380.95	2380.95
4	Supporting Material	1789.57	3522.98	3522.98	3522.98	2718.16	4815.23	4815.23	4815.23	2156.14	4510.48	4510.48	4510.48
5	Organic Fertilizer	2692.14	3210.97	3249.45	3249.45	3294.69	4049.73	4076.44	4076.44	3941.89	4073.01	4073.01	4073.01
6	Chemical Fertilizer	658.33	658.33	658.33	663.08	1362.07	1579.55	1579.55	1579.55	976.10	976.10	976.10	976.10
7	Insecticide	746.15	746.15	746.15	746.15	930.44	930.44	930.44	930.44	903.26	903.26	903.26	903.26
	Irrigation Pump	5000.00				5000.00				5000.00			
8	Irrigation	690.05	690.05	690.05	690.05	737.41	737.41	737.41	737.41	804.19	804.19	804.19	804.19
9	Miscellaneous	347.22	347.22	347.22	347.22	347.22	347.22	347.22	347.22	390.00	390.00	390.00	390.00
10	Labour Cost for Land Preparation	1301.87				1390.47				1354.88			
11	Labour Cost for *Boroj* Construction and Maintenance	2468.87	1335.55	1334.38	1335.55	2420.50	1487.26	1487.26	1487.26	2578.67	1330.04	1330.12	1330.12
12	Labour Cost for Planting	1379.47				1325.12				1642.62			
13	Labour Cost for Lowering and tying	2989.81	5979.62	5979.62	5979.62	3416.44	6832.88	6832.88	6832.88	4343.28	8686.56	8686.56	8686.56
14	Labour Cost for Plucking	772.24	1544.47	1544.47	1544.47	840.00	1680.00	1680.00	1680.00	698.18	1396.36	1396.36	1396.36
15	Labour Cost for Packing	783.53	1567.06	1567.06	1567.06	840.00	1680.00	1680.00	1680.00	698.18	1396.36	1396.36	1396.36
16	Transport cost for *Boroj* Material	417.33	417.33	417.33	417.33	501.74	501.74	501.74	501.74	392.30	392.30	392.30	392.30
17	Working Capital	35866.56	27919.36	27945.77	27951.69	47734.49	34320.01	34346.72	34346.72	39362.03	32319.66	32319.74	32319.74
18	Interest on Working Capital @ 6%	2151.99	1675.16	1676.75	1677.10	2864.07	2059.20	2060.80	2060.80	2361.72	1939.18	1939.18	1939.18
	Cost A1	38018.56	29594.52	29622.51	29628.79	50598.55	36379.21	36407.52	36407.52	41723.75	34258.84	34258.93	34258.93
19	Rent Paid for Leased Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cost A2: Cost A1+Rent Paid for Leased Land	38018.56	29594.52	29622.51	29628.79	50598.55	36379.21	36407.52	36407.52	41723.75	34258.84	34258.93	34258.93
20	Interest on Fixed Capital @ 6%	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31

	Cost B1 (A2+ Interest on Fixed Capital @ 6%)	38110.86	29686.83	29714.82	29721.10	50690.86	36471.52	36499.83	36499.83	41816.06	34351.15	34351.24	34351.24
21	Rental Value of Owned Land	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46
	Cost B2 (B1+ Rental Value of Owned Land)	39649.32	31225.29	31253.28	31259.56	52229.32	38009.98	38038.29	38038.29	43354.52	35889.61	35889.70	35889.70
22	Imputed Value of Family Labour	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00
	Cost C1 (B1+ Imputed Value of Family Labour)	44110.86	35686.83	35714.82	35721.10	56690.86	42471.52	42499.83	42499.83	47816.06	40351.15	40351.24	40351.24
	Cost C2 (B2+Imputed Value of Family Labour)	45649.32	37225.29	37253.28	37259.56	58229.32	44009.98	44038.29	44038.29	49354.52	41889.61	41889.70	41889.70
	Gross Return	11750.47	64145.08	64145.08	50597.03	20406.43	107424.85	107424.85	85220.85	16086.11	85823.29	85823.29	67939.60
	Net Return Over												
	A2	-26268.08	34550.56	34522.56	20968.24	-30192.13	71045.64	71017.33	48813.33	-25637.64	51564.45	51564.36	33680.67
	B2 (B1+ Rental Value of Owned Land)	-27898.85	32919.79	32891.80	19337.47	-31822.89	69414.88	69386.56	47182.56	-27268.41	49933.68	49933.59	32049.91
	C1 (B1+ Imputed Value of Family Labour)	-32360.39	28458.25	28430.26	14875.93	-36284.43	64953.34	64925.02	42721.02	-31729.95	45472.14	45472.05	27588.37
	C2 (B2+Imputed Value of Family Labour)	-33898.85	26919.79	26891.80	13337.47	-37822.89	63414.88	63386.56	41182.56	-33268.41	43933.68	43933.59	26049.91
	B:C Ratio												
	A2	0.31	2.17	2.17	1.71	0.40	2.95	2.95	2.34	0.39	2.51	2.51	1.98
	B2	0.30	2.05	2.05	1.62	0.39	2.83	2.82	2.24	0.37	2.39	2.39	1.89
	C1	0.27	1.80	1.80	1.42	0.36	2.53	2.53	2.01	0.34	2.13	2.13	1.68
	C2	0.26	1.72	1.72	1.36	0.35	2.44	2.44	1.94	0.33	2.05	2.05	1.62

Table 7: Net Present Value of betel leaf cultivation in the study area

Net Present Value (NPV) of different types of betel leaf									
Types and size of betel leaf									
	Bangla			***Mitha***			***Sanchi***		
Discount Rate	Small	Medium	Big	Small	Medium	Big	Small	Medium	Big
5%	-44427.6	122385.9	282612.4	53683.41	343489.3	831851.3	3953.131	229877.8	427815.2
10%	-40854.4	90157.06	215994.6	33543.24	261149.7	644695.8	-3218.79	174217	329671.7

Net Present Value of betel leaf cultivation

Net present values were (Table 7) calculated for the cultivation period of 10 years for all betel leaf types and size of betel leaf production assuming the discount rate as 5% (minimum interest rate) and 10% (maximum interest rate). The NPV of betel leaf cultivation was found to be positive for two discount rates under this condition, except for the small sized betel leaf cultivation. In case of small *Bangla* leaf cultivation, the NPV is negative (-44427.6 and -40854.4) for the 5% and 10% discount rate. Thus, it can be said that small sized *Bangla* leaf cultivation is not a profitable cultivation practice in the study area under the presently existent agro-economic conditions.

Table 8: Estimated NPV for medium size *Bangla* leaf

Statistic	Forecast values
Trials	10,000
Base Case	Rs. 1,22,100.14
Mean	Rs. 1,43,387.82
Median	Rs. 1,43,213.87
Standard Deviation	Rs. 41,093.25
Variance	Rs. 1,68,86,54,965.89
Skewness	0.0162
Kurtosis	3.03
Coeff. of Variation	0.2866
Minimum	Rs. -20,668.23
Maximum	Rs. 3,02,542.66
Mean Std. Error	₹ 410.93

Uncertainty analysis

Since, the NPV of small sized *Bangla* leaf cultivation is negative in both 5% and 10% discount rates, the risk or economic viability of medium sized *Bangla* leaf cultivation has been analysed. The result of the simulation analysis (Table 8) shows that the NPV for investing in medium sized betel leaf cultivation and using it for 10 years is estimated as Rs. 1,22,100.14, with probabilistic NPV being Rs. 1,43,387.82. Both the NPV and probabilistic NPV being positive suggests that investment in medium size *Bangla* leaf cultivation is profitable. Furthermore, the lower standard error indicates that investment in medium size *Bangla* betel leaf cultivation is again viable. Fig. 22 shows that the probability of getting a positive NPV was almost 100%, while Fig. 23 shows that the probability of getting the estimated probabilistic NPV that is greater or equal to the mean probabilistic NPV was almost 50%. So, the findings show that the probability of obtaining a positive NPV is greater than the probability of getting a negative NPV, which will establish that the investment is not viable.

Table 6: Cost Structure, Returns and Benefit-Cost Ratio of betel leaf cultivation in the study area

		Cost of betel vine cultivation (Rs. / 5 decimal)											
		Bangla				***Mitha***				***Sanchi***			
Sl. No.	**Item**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 year**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 Year**	**1st year**	**2 to 4 Year**	**5 to 7 Year**	**8 to10 Year**
1	*Boroj* Material	7913.52	4609.30	4598.40	4598.40	8049.53	4628.04	4628.04	4628.04	8129.36	5080.04	5080.04	5080.04
2	Sapling	2818.46				9510.18				2972.02			
3	Soil	3098.03	3290.34	3290.34	3290.34	5050.50	5050.50	5050.50	5050.50	2380.95	2380.95	2380.95	2380.95
4	Supporting Material	1789.57	3522.98	3522.98	3522.98	2718.16	4815.23	4815.23	4815.23	2156.14	4510.48	4510.48	4510.48
5	Organic Fertilizer	2692.14	3210.97	3249.45	3249.45	3294.69	4049.73	4076.44	4076.44	3941.89	4073.01	4073.01	4073.01
6	Chemical Fertilizer	658.33	658.33	658.33	663.08	1362.07	1579.55	1579.55	1579.55	976.10	976.10	976.10	976.10
7	Insecticide	746.15	746.15	746.15	746.15	930.44	930.44	930.44	930.44	903.26	903.26	903.26	903.26
	Irrigation Pump	5000.00				5000.00				5000.00			
8	Irrigation	690.05	690.05	690.05	690.05	737.41	737.41	737.41	737.41	804.19	804.19	804.19	804.19
9	Miscellaneous	347.22	347.22	347.22	347.22	347.22	347.22	347.22	347.22	390.00	390.00	390.00	390.00
10	Labour Cost for Land Preparation	1301.87				1390.47				1354.88			
11	Labour Cost for *Boroj* Construction and Maintenance	2468.87	1335.55	1334.38	1335.55	2420.50	1487.26	1487.26	1487.26	2578.67	1330.04	1330.12	1330.12
12	Labour Cost for Planting	1379.47				1325.12				1642.62			
13	Labour Cost for Lowering and tying	2989.81	5979.62	5979.62	5979.62	3416.44	6832.88	6832.88	6832.88	4343.28	8686.56	8686.56	8686.56
14	Labour Cost for Plucking	772.24	1544.47	1544.47	1544.47	840.00	1680.00	1680.00	1680.00	698.18	1396.36	1396.36	1396.36
15	Labour Cost for Packing	783.53	1567.06	1567.06	1567.06	840.00	1680.00	1680.00	1680.00	698.18	1396.36	1396.36	1396.36
16	Transport cost for *Boroj* Material	417.33	417.33	417.33	417.33	501.74	501.74	501.74	501.74	392.30	392.30	392.30	392.30
17	Working Capital	35866.56	27919.36	27945.77	27951.69	47734.49	34320.01	34346.72	34346.72	39362.03	32319.66	32319.74	32319.74
18	Interest on Working Capital @ 6%	2151.99	1675.16	1676.75	1677.10	2864.07	2059.20	2060.80	2060.80	2361.72	1939.18	1939.18	1939.18
	Cost A1	38018.56	29594.52	29622.51	29628.79	50598.55	36379.21	36407.52	36407.52	41723.75	34258.84	34258.93	34258.93
19	Rent Paid for Leased Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cost A2: Cost A1+Rent Paid for Leased Land	38018.56	29594.52	29622.51	29628.79	50598.55	36379.21	36407.52	36407.52	41723.75	34258.84	34258.93	34258.93

20	Interest on Fixed Capital @ 6%	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31	92.31
	Cost B1 (A2+ Interest on Fixed Capital @ 6%)	38110.86	29686.83	29714.82	29721.10	50690.86	36471.52	36499.83	36499.83	41816.06	34351.15	34351.24	34351.24
21	Rental Value of Owned Land	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46	1538.46
	Cost B2 (B1+ Rental Value of Owned Land)	39649.32	31225.29	31253.28	31259.56	52229.32	38009.98	38038.29	38038.29	43354.52	35889.61	35889.70	35889.70
22	Imputed Value of Family Labour	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00
	Cost C1 (B1+ Imputed Value of Family Labour)	44110.86	35686.83	35714.82	35721.10	56690.86	42471.52	42499.83	42499.83	47816.06	40351.15	40351.24	40351.24
	Cost C2 (B2+Imputed Value of Family Labour)	45649.32	37225.29	37253.28	37259.56	58229.32	44009.98	44038.29	44038.29	49354.52	41889.61	41889.70	41889.70
	Gross Return	11750.47	64145.08	64145.08	50597.03	20406.43	107424.85	107424.85	85220.85	16086.11	85823.29	85823.29	67939.60
	Net Return Over												
	A2	-26268.08	34550.56	34522.56	20968.24	-30192.13	71045.64	71017.33	48813.33	-25637.64	51564.45	51564.36	33680.67
	B2 (B1+ Rental Value of Owned Land)	-27898.85	32919.79	32891.80	19337.47	-31822.89	69414.88	69386.56	47182.56	-27268.41	49933.68	49933.59	32049.91
	C1 (B1+ Imputed Value of Family Labour)	-32360.39	28458.25	28430.26	14875.93	-36284.43	64953.34	64925.02	42721.02	-31729.95	45472.14	45472.05	27588.37
	C2 (B2+Imputed Value of Family Labour)	-33898.85	26919.79	26891.80	13337.47	-37822.89	63414.88	63386.56	41182.56	-33268.41	43933.68	43933.59	26049.91
	B:C Ratio												
	A2	0.31	2.17	2.17	1.71	0.40	2.95	2.95	2.34	0.39	2.51	2.51	1.98
	B2	0.30	2.05	2.05	1.62	0.39	2.83	2.82	2.24	0.37	2.39	2.39	1.89
	C1	0.27	1.80	1.80	1.42	0.36	2.53	2.53	2.01	0.34	2.13	2.13	1.68
	C2	0.26	1.72	1.72	1.36	0.35	2.44	2.44	1.94	0.33	2.05	2.05	1.62

Table 7: Net Present Value of betel leaf cultivation in the study area

Net Present Value (NPV) of different types of Betel leaf									
Types and size of betel leaf									
	Bangla			***Mitha***			***Sanchi***		
Discount Rate	Small	Medium	Big	Small	Medium	Big	Small	Medium	Big
5%	-44427.6	122385.9	282612.4	53683.41	343489.3	831851.3	3953.131	229877.8	427815.2
10%	-40854.4	90157.06	215994.6	33543.24	261149.7	644695.8	-3218.79	174217	329671.7

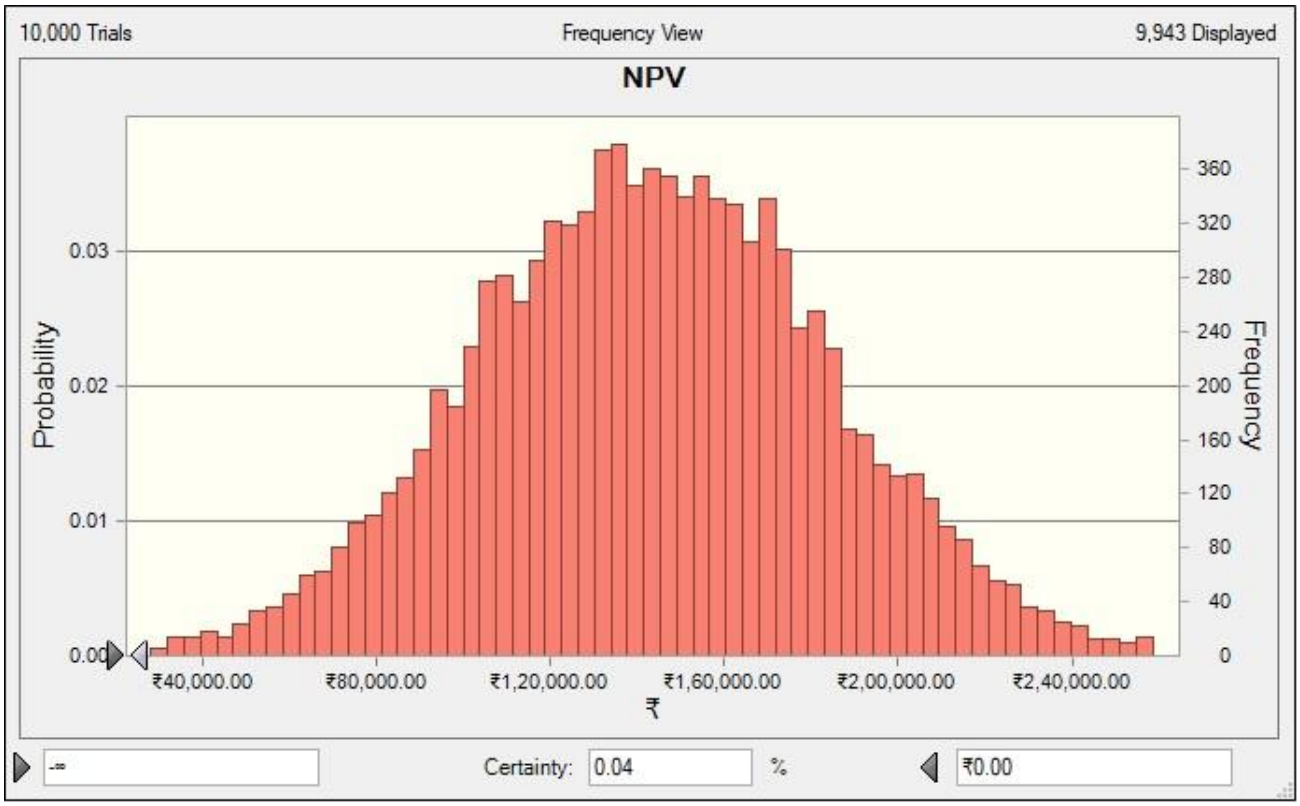


Fig. 22: Cumulative distribution of NPV showing the probability of obtaining a positive NPV

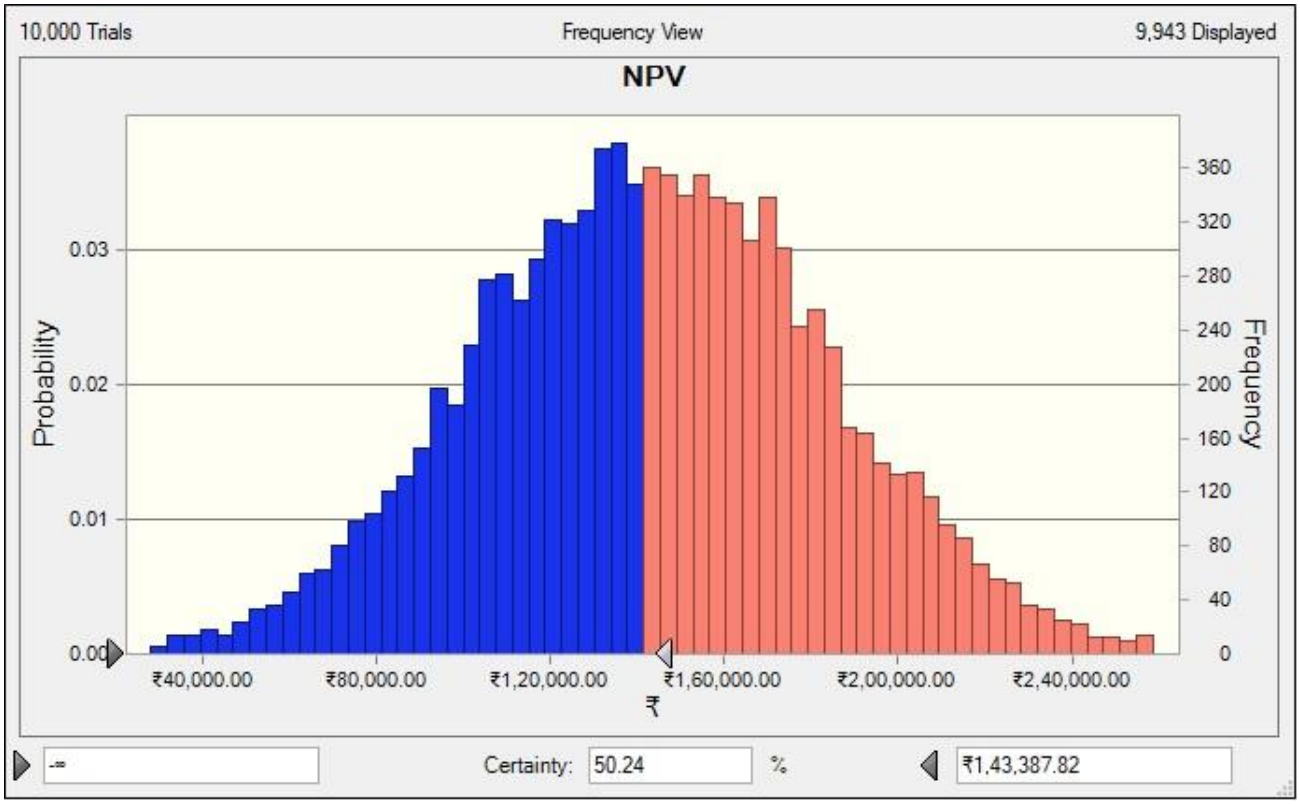


Fig. 23: Cumulative distribution of NPV showing the probability of getting the mean NPV

Marketing cost and margin of betel leaf

The movement of betel leaves from producer to consumer follows several marketing channels (defined before on page 15, Fig. 10) and intermediaries. The total marketing cost (Table 9) incurred by the farmer, *Aratdar*, commission agent, primary wholesaler, secondary wholesaler, local trader and retailer varies in the different operative channels. The marketing cost of the farmer (producer) is highest in Channel 3 (Rs. 838.21/ 1000 leaves) and lowest in Channel 5 (Rs. 690.21/ 1000 leaves). Marketing cost of *Aratdar* is negligible and the marketing cost of commission agents is Rs. 246.00/ 1000 leaves. Marketing margins of *Aratdar*s, commission agents and other actors in the betel leaf marketing channel also varies with the channel followed. The commission agents' (Rs. 154.84/ 1000 leaves) and secondary wholesalers' (Rs. 195.06/ 1000 leaves) marketing margin are the highest as per the marketing channel of betel leaf.

Price Spread in betel leaf marketing

Price spread (Table 10) of betel leaf marketing shows that the producers' share in consumers' rupee was highest (77.54%) in Channel 4 and the marketing cost incurred by producer and local trader was 13.33%. Marketing cost incurred by producers, *Aratdar*s, commission agents, secondary wholesalers and retailers in Channel 1 was 49.12%. The highest marketing margin was seen in Channel 6 (30.10%). Channels 4 and 3 were found to be more profitable than the other channels.

Marketing efficiency

Marketing efficiency in betel leaf marketing (Table 11) was highest in Channel 3 (7.53), followed by that in Channel 4 (7.50), channel 2 (3.12), Channel 6 (2.25), Channel 5 (2.12) and Channel 1 (2.04). The high rate of marketing margin intercepted by different marketing intermediaries resulted in poor marketing efficiency in Channels 1, 5, 6 and 2.

Table 9: Marketing Costs and Margins for betel Leaf (Rs. / 1000 leaves)

Sl. No.	Particulars	Total Price in different channel					
		Channel- I	**Channel- II**	**Channel-III**	**Channel- IV**	**Channel- V**	**Channel- VI**
I	**Marketing Cost incurred by producer**						
1	Counting and Packing charge	66.00	66.00	66.00	66.00	66.00	66.00
2	Transport cost	88.66	88.66	40.00	0.00	88.66	88.66
3	Commission charge	50.00	50.00	0.00	0.00	50.00	50.00
4	Market fee	10.00	10.00	0.00	0.00	10.00	10.00
5	Other costs	61.13	61.13	20.00	0.00	61.13	61.13
6	Total marketing cost	275.80	275.80	126.00	66.00	275.80	275.80
7	Selling price of producer	686.21	686.21	838.21	770.21	690.21	691.21
II	**Marketing Cost incurred by *Aratdar***						
1	Labour charge	0.02	0.02	0.00	0.00	0.02	0.02
2	Market fee	0.00	0.00	0.00	0.00	0.00	0.00
3	Tax	0.02	0.02	0.00	0.00	0.02	0.02
4	Other costs	0.03	0.03	0.00	0.00	0.03	0.03
5	Total marketing cost	0.06	0.06	0.00	0.00	0.06	0.06
6	Selling price of *Aratdar*	786.27	786.27	0.00	0.00	786.27	786.27
7	Marketing margin of *Aratdar*	100.00	100.00	0.00	0.00	100.00	100.00
III	**Marketing Cost incurred by Commission Agent**						
1	Labour cost	18.75	0.00	0.00	0.00	0.00	0.00
2	Packing material cost	50.00	0.00	0.00	0.00	0.00	0.00
3	Transport cost	175.00	0.00	0.00	0.00	0.00	0.00
4	Market fee	0.50	0.00	0.00	0.00	0.00	0.00
5	Traders' Union fee	0.00	0.00	0.00	0.00	0.00	0.00
6	Other costs	1.75	0.00	0.00	0.00	0.00	0.00
7	Total Marketing cost	246.00	0.00	0.00	0.00	0.00	0.00
8	Selling Price of Commission Agent	1187.11	0.00	0.00	0.00	0.00	0.00
9	Marketing Margin of Commission Agent	154.84	0.00	0.00	0.00	0.00	0.00

IV		**Marketing Cost incurred by Primary Wholesaler**						
	1	Packing cost	0.00	20.00	0.00	0.00	20.00	20.00
	2	Transport cost	0.00	30.00	0.00	0.00	30.00	30.00
	3	Market fee	0.00	0.50	0.00	0.00	0.50	0.50
	4	Total marketing cost	0.00	50.50	0.00	0.00	50.50	50.50
	5	Selling price of Primary Wholesaler	0.00	920.45	0.00	0.00	920.45	920.45
	6	Marketing margin of Primary Wholesaler	0.00	83.68	0.00	0.00	83.68	83.68
V		**Marketing Cost incurred by secondary Wholesaler**						
	1	Packing cost	30.00	0.00	0.00	0.00	30.00	30.00
	2	Transport cost	300.00	0.00	0.00	0.00	300.00	300.00
	3	Other costs	50.00	0.00	0.00	0.00	50.00	50.00
	4	Total marketing cost	380.00	0.00	0.00	0.00	380.00	380.00
	5	Selling price of Secondary Wholesaler	1755.16	0.00	0.00	0.00	1495.52	1495.52
	6	Marketing margin of Secondary Wholesaler	188.05	0.00	0.00	0.00	195.06	195.06
VI		**Marketing Cost incurred by Local Trader**						
	1	Packing cost	0.00	0.00	0.00	20.00	0.00	0.00
	2	Transport cost	0.00	0.00	0.00	30.00	0.00	0.00
	3	Other costs	0.00	0.00	0.00	5.00	0.00	0.00
	4	Total marketing cost	0.00	0.00	0.00	55.00	0.00	0.00
	5	Selling price of Local Trader	0.00	0.00	0.00	907.73	0.00	0.00
	6	Marketing margin of Local Trader	0.00	0.00	0.00	82.52	0.00	0.00
VII		**Marketing cost incurred by the Retailer**						
	1	Transport cost	5.000	5.000	0.000	0.000	0.000	5.000
	2	Market fee	1.000	1.000	1.000	0.000	0.000	1.000
	3	Other costs	1.000	1.000	1.000	0.000	0.000	1.000
	4	Total marketing cost	7.000	7.000	2.000	0.000	0.000	7.000
	5	Retailer's marketing margin	88.108	111.290	126.031	0.000	0.000	105.176
	6	**Purchase Price of Consumer or Selling Price of Retailer**	**1850.270**	**1038.797**	**964.239**	**907.729**	**1495.515**	**1607.691**

Table 10: Price Spread in marketing of betel leaf (Rs. / 1000 leaves)

Sl. No.	Particulars	Total Price (Rs. / 1000 leaves)					
		Channel- I	Channel- II	Channel-III	Channel- IV	Channel- V	Channel- VI
1	Net Price Received by the Producer	410.41	410.41	712.21	704.21	414.41	415.41
		(22.18)	(39.51)	(73.86)	(77.58)	(27.71)	(25.84)
2	Total Marketing cost incurred by different stakeholders	908.86	333.36	128.00	121.00	706.36	713.36
		(49.12)	(32.09)	(13.27)	(13.33)	(47.23)	(44.37)
3	Total Marketing Margin of different Stakeholders	531.00	294.97	126.03	82.52	378.74	483.91
		(28.70)	(28.40)	(13.07)	(9.09)	(25.32)	(30.10)
4	Purchase Price of Consumer	1850.27	1038.80	964.24	907.73	1495.52	1607.69
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

*Figure in the parenthesis indicates the percentage to total)

Table 11: Marketing Efficiency of betel leaf

Sl. No.	Particulars	Unit	Channel- I	Channel- II	Channel-III	Channel- IV	Channel- V	Channel- VI
1	Consumer's Purchase Price or Retailer's Sale price	Rs. / 1000 leaves	1850.27	1038.80	964.24	907.73	1495.52	1607.69
2	Total Marketing Cost	Rs. / 1000 leaves	908.86	333.36	128.00	121.00	706.36	713.36
3	Total Net Margin of Intermediaries	Rs. / 1000 leaves	531.00	294.97	126.03	82.52	378.74	483.91
4	Net Price Received by Farmers	Rs. / 1000 leaves	410.41	410.41	712.21	704.21	414.41	415.41
	Index of Marketing Efficiency							
1	Shepherd's Method	Ratio	2.04	3.12	7.53	7.50	2.12	2.25
2	Producer share in consumer's Rupee	Percentage	22.18	39.51	73.86	77.58	27.71	25.84

Multiple Regression

Factors affecting or influencing the income of betel leaf farmers was analysed using multiple regression techniques, since income is ultimately one of the most the important parameters of the continued agro-economic viability of the betel leaf agribusiness. Assumption tests of the data for multiple regression are necessary and various assumptions tests were done beforehand, as follows:

- **Normality Test**: Normality plot shows that the data of farmers income lie around the diagonal line (Fig. 24), that indicates the variables are normally distributed.

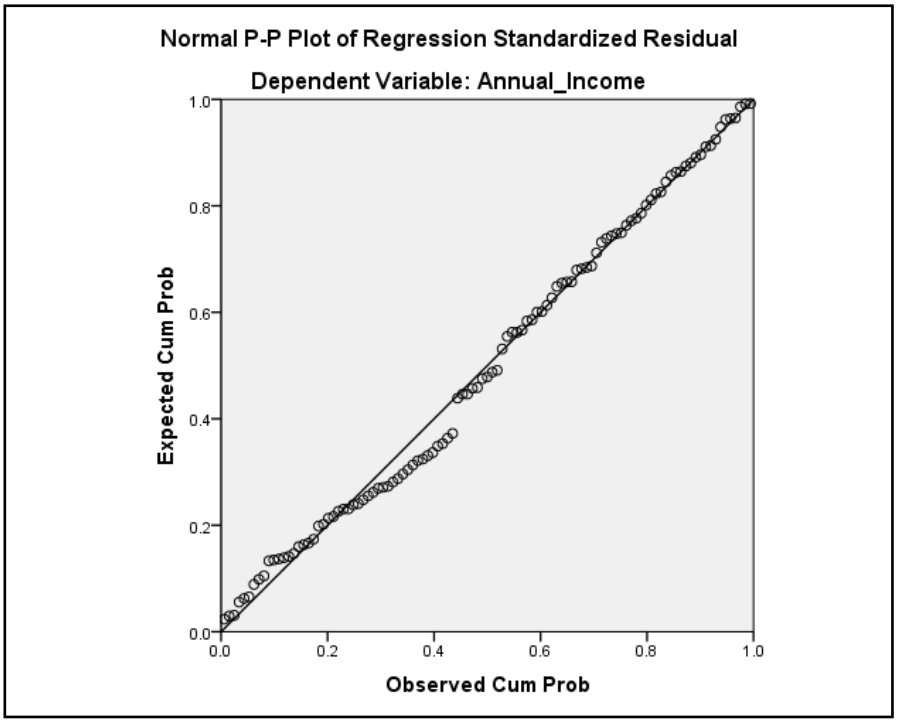


Fig. 24: Standardized residual plot of multiple regression

- **Heteroscedasticity Test**: The data was spread over above and below the 0 in the Y axis (Fig. 25), so that it can be concluded that there is no heteroscedasticity problem in this model.

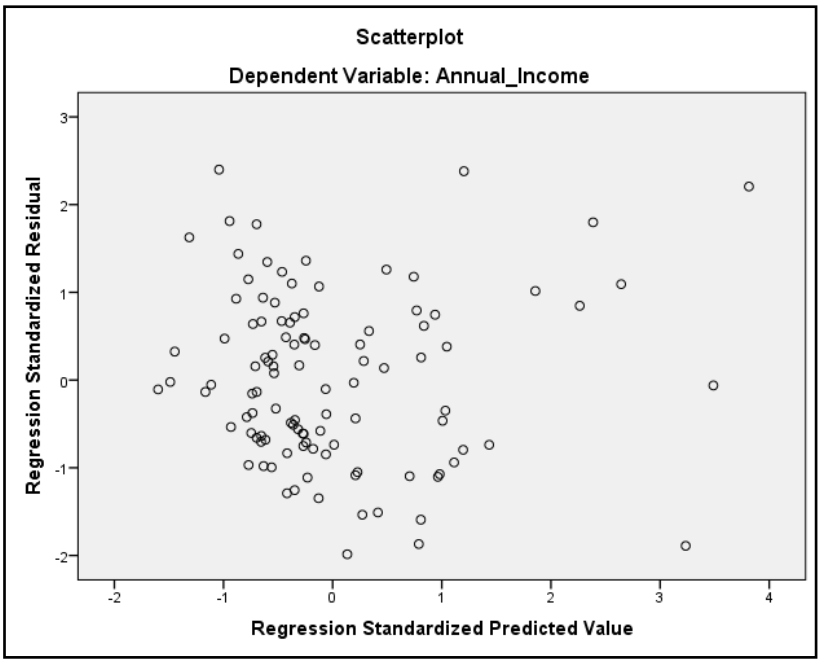


Fig. 25: Scatter plot of multiple regression

- **Multicollinearity Test**: The result of multicollinearity statistics (Table 12) shows that the independent variables' VIF values are less than 2.0 and the tolerance values are greater than 0.1. Thus, no multicollinearity was found between the independent variables.

Table 12: Collinearity statistics of multiple regression

Coefficients[a]			
		Collinearity Statistics	
Model		Tolerance	VIF
1	(Constant)		
	Type of Betel Leaf Farmer's Produce	.608	1.646
	Vine cost	.722	1.385
	Fertilizer and pesticide cost	.611	1.636
	Cultivator's Primary Occupation	.972	1.029
	Size of betel vine land	.943	1.061
	Year of experience in betel cultivation	.962	1.040

a. Dependent Variable: Annual Income

Regression Model Validation and Results

- **Coefficient of Determination**: Table 13 shows the adjusted R square value as .546. Thus the independent variables in betel leaf cultivation can explain the dependent variable, i.e. farmers' income up to 54.6%.
- **F test and Model Significance**: The result (Table 14) shows that the significance value .000 is lower than 0.05, which means that the model is significant and that the independent variables do affect the dependent variable, i.e. farmers' incomes.
- **Result of t- Test**: Table 15 shows that the explanatory variable *Fertilizer and pesticide cost* and *Vine cost* are significant at 1% level, the types of leaf that the farmers produce is significant at 5% level and the cultivator's primary occupation is also significant, but at 10% level of significance. However, the size of betel vine land and year of experience in cultivation do not significantly determine the farmers' income.

Table 13: Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.756[a]	.571	.546	8925.62064

a. Predictors: (Constant), Year of experience in betel cultivation, Vine cost, Cultivator's Primary Occupation, Size of betel vine land, Fertilizer and pesticide cost, Type of Betel Leaf Farmer's Produce

b. Dependent Variable: Annual Income

Table 14: Result of F Test and model significance

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	10624820469.993	6	1770803411.665	22.228	.000[b]
	Residual	7966670373.461	100	79666703.735		
	Total	18591490843.453	106			

a. Dependent Variable: Annual Income

b. Predictors: (Constant), Year of experience in betel cultivation, Vine cost, Cultivator's Primary Occupation, Size of betel vine land, Fertilizer pesticide cost, Type of Betel Leaf Farmer's Produce

Table 15: Output of t Test of the determining factors affecting income

Coefficients[a]						
		Unstandardized Coefficients		**Standardized Coefficients**		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	5277.046	4640.148		1.137	.258
	Type of Betel Leaf Farmer's Produce	3795.690	1338.450	.238	2.836	.006
	Vine cost	1.123	.310	.279	3.621	.000
	Fertilizer pesticide cost	2.251	.515	.366	4.368	.000
	Cultivator's Primary Occupation	3046.754	1583.631	.128	1.924	.057
	Size of betel vine land	-108.271	74.947	-.097	-1.445	.152
	Year of experience in betel cultivation	138.928	90.403	.103	1.537	.128

a. Dependent Variable: Annual Income

Price Forecasting of different types of betel leaf

Forecasting of betel leaf price is very much needed for profit maximization since the price of betel leaf fluctuates seasonally. To forecast the market price of different varieties of betel leaf, time series data of monthly average prices for the period 2004 to 2019 were taken. First of all, the assumptions have been checked and fitted. The best fitted model for *Bangla* leaf (Table 16), *Mitha* leaf (Table 18) and *Sanchi* leaf (Table 20) were ARIMA ((0,0,2) (1,1,1)), ARIMA((0,0,3) (1,0,1)), and ARIMA((0,1,3) (1,1,1). The selected model for *Bangla* leaf price (Table 17), *Mitha* leaf price (Table 19) and *Sanchi* leaf price (Table 21), all are significant, with significance value less than 0.05. The results show that the predicted value of the *Bangla* leaf (Fig. 26) price is increasing in case of medium and large sized leaves, but for small leaves, the predicted value shows a decreasing price trend. The predicted value of *Mitha* leaf (Fig. 27) shows constant price for all size categories, although a slightly increasing trend can be found in case of the medium sized *Mitha* leaf. The predicted price for *Sanchi* leaf (Fig. 28) shows decreasing trend for the big leaf size, but for the medium size leaf the forecasting price shows an increasing trend. Since the betel leaf price is more stable for the *Mitha* variety, this category is the best for farmers to ensure stable profit generation.

Table 16: ARIMA model description for *Bangla* leaf

Model Description			
			Model Type
Model ID	Price of small leaf	Model_1	ARIMA (0,0,2) (1,1,1)
	Price of medium leaf	Model_2	ARIMA (0,0,2) (1,1,1)
	Price of large leaf	Model_3	ARIMA (0,0,2) (1,1,1)

Table 17: ARIMA model statistics for *Bangla* leaf

Model Statistics								
Model	Number of Predictors	Model Fit statistics			Ljung-Box Q (18)			Number of Outliers
		Stationary R-squared	R-squared	RMSE	Statistics	DF	Sig.	
Price of small leaf-Model_1	0	0.804	0.855	980.91	42.864	14	0.000	0
Price of medium leaf-Model_2	0	0.716	0.833	1724.8	27.036	14	0.019	0
Price of large leaf-Model_3	0	0.774	0.848	2231.3	40.097	14	0.000	0

Table 18: ARIMA model description for *Mitha* leaf

Model Description			
			Model Type
Model ID	Price of small leaf	Model_1	ARIMA (0,0,3) (1,0,1)
	Price of medium leaf	Model_2	ARIMA (0,0,3) (1,0,1)
	Price of large leaf	Model_3	ARIMA (0,0,3) (1,0,1)

Table 19: ARIMA model statistics for *Mitha* leaf

Model Statistics								
Model	Number of Predictors	Model Fit statistics			Ljung-Box Q (18)			Number of Outliers
		Stationary R-squared	R-squared	RMSE	Statistics	DF	Sig.	
Price of small leaf-Model_1	0	0.849	0.849	2392.1	70.359	13	0.000	0
Price of medium leaf-Model_2	0	0.822	0.822	6084.1	50.617	13	0.000	0
Price of large leaf-Model_3	0	0.78	0.78	9214.3	53.007	13	0.000	0

Table 20: ARIMA model description for *Sanchi* leaf

Model Description			
			Model Type
Model ID	Price of small leaf	Model_1	ARIMA (0,1,3) (1,1,1)
	Price of medium leaf	Model_2	ARIMA (0,1,3) (1,1,1)
	Price of large leaf	Model_3	ARIMA (0,1,3) (1,1,1)

Table 21: ARIMA model statistics for *Sanchi* leaf

Model Statistics								
Model	**Number of Predictors**	**Model Fit statistics**			**Ljung-Box Q (18)**			**Number of Outliers**
		Stationary R-squared	**R-squared**	**RMSE**	**Statistics**	**DF**	**Sig.**	
Price of small leaf-Model_1	0	0.456	0.885	923.96	26.819	13	0.013	0
Price of medium leaf-Model_2	0	0.444	0.885	1469.8	37.145	13	0.000	0
Price of large leaf-Model_3	0	0.467	0.878	2044.5	25.448	13	0.02	0

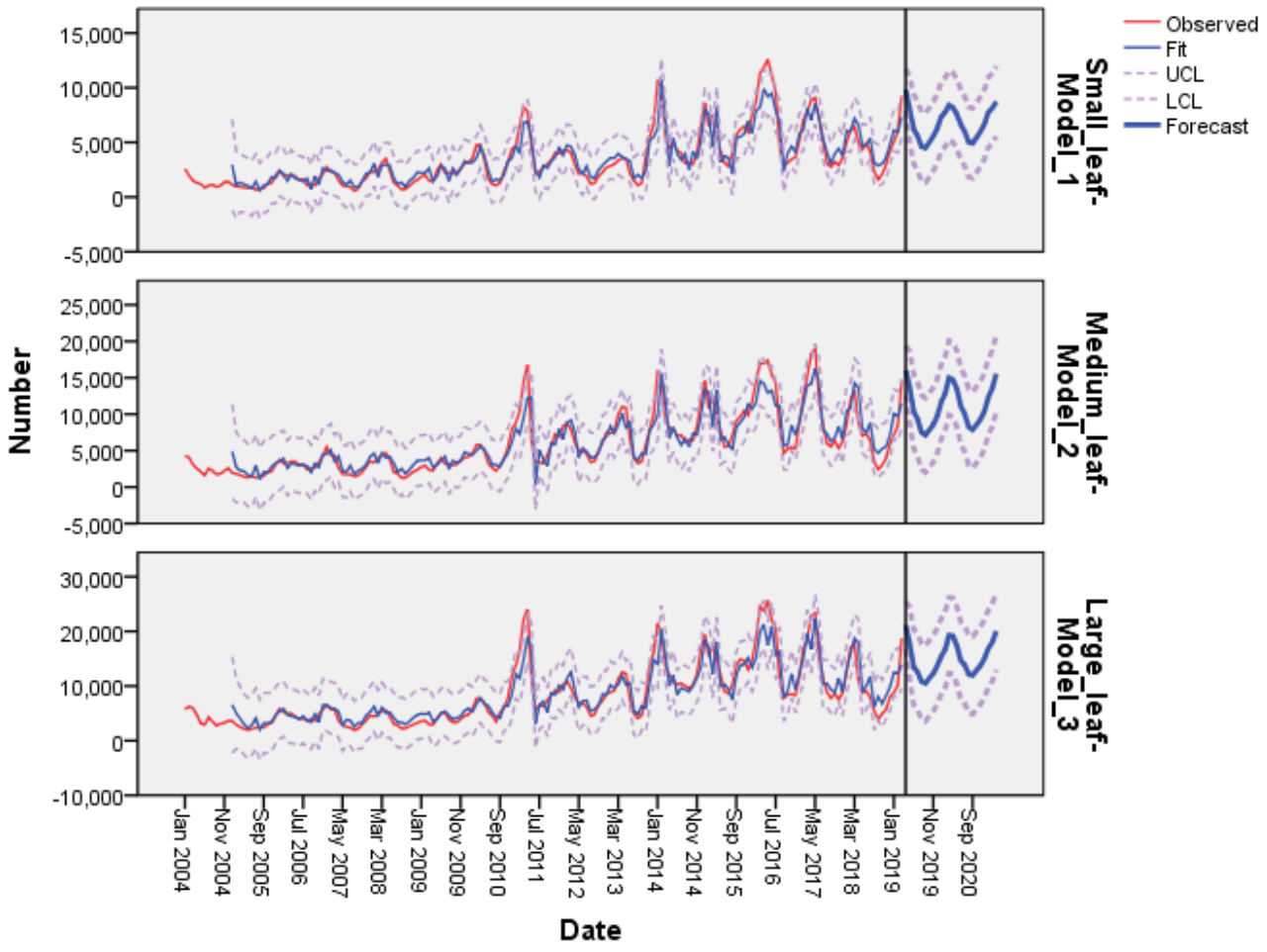


Fig. 26: Price forecasting for *Bangla* leaf

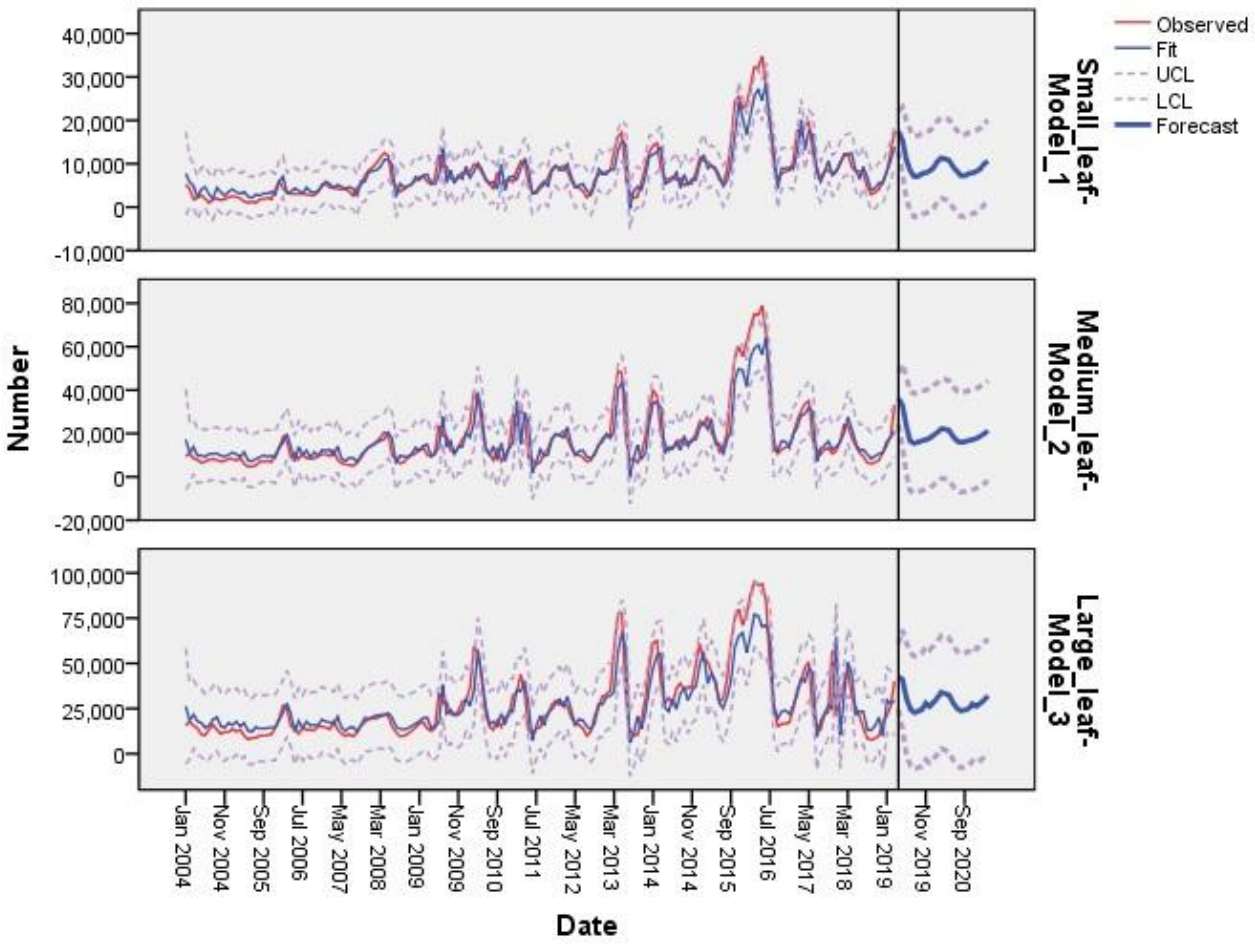


Fig. 27: Price forecasting for *Mitha* leaf

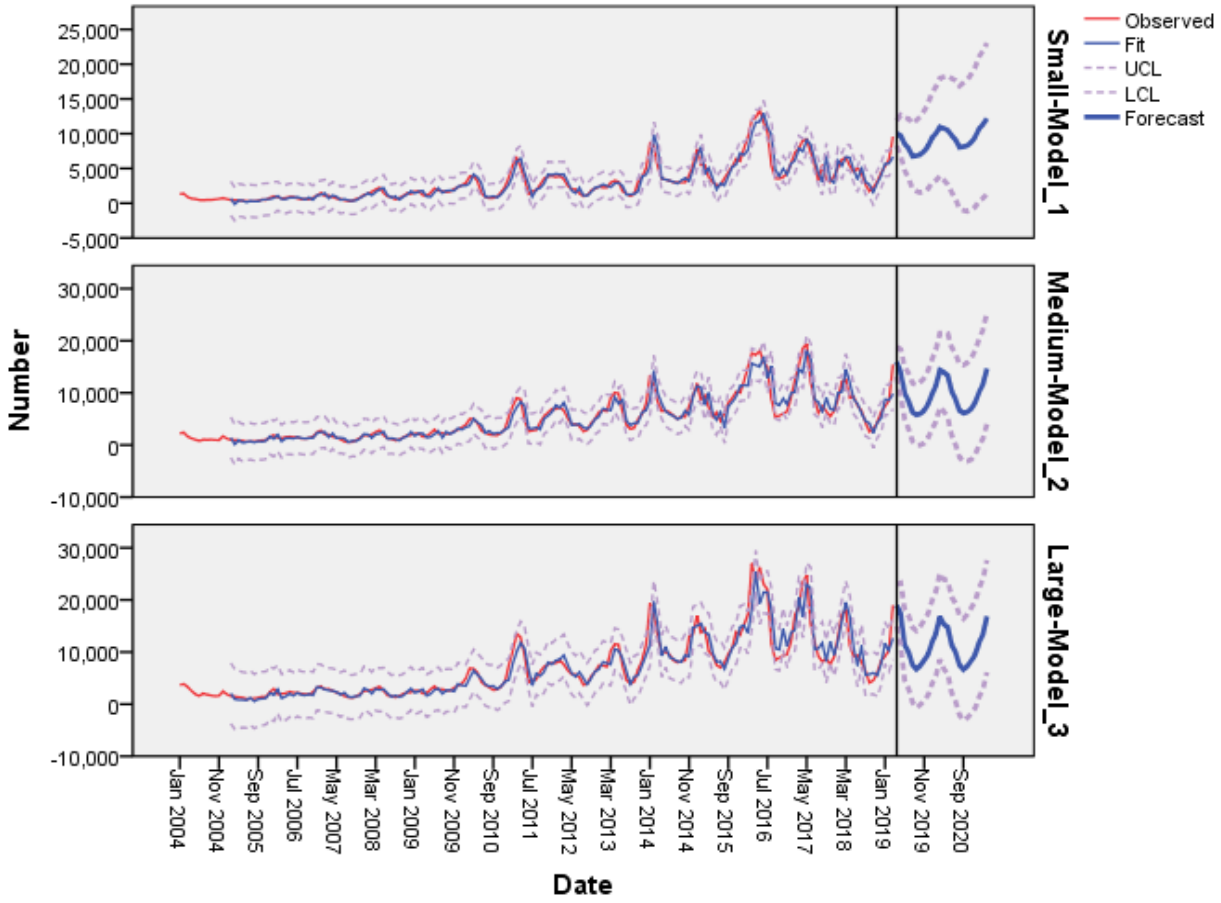


Fig. 28: Price forecasting for *Sanchi* leaf

Chapter - VII **Effect of episodic disturbances and continued viability**

The methods followed (Fig. 29) to meet the stated objectives was as follows-

- Constraints in cultivation and marketing was analysed using the Likert Scale and Garrett's method to see the factors limiting profits for farmers. Garrett's Ranking Technique (Garrett and Woodworth, 1969) was used to analyse the problems perceived by them in cultivation and marketing. The percent position of each rank was converted into scores by using the table given.

$$\text{Percent Position} = 100\ (R_{ij}-0.5)/N_j$$

where, R_{ij}= Rank of i^{th} constraint by j^{th} farmer; N_j= Number of constraints ranked by j^{th} farmer

- Marketing constraints as per the marketing stakeholders (*Aratdar* and Commission Agent/Trader) was also analysed using Garrett's Ranking Technique and Problem Confrontation Index (Ali, 2014) method to identify the impediments that stakeholders faced in marketing the betel leaf from local markets to different national and international destinations.

$$\text{Problem Confrontation Index (PCI)} = P_{VL}\times 1 + P_V\times 2 + P_M\times 3 + P_L\times 4 + P_{VL}\times 5$$

where, P_{VL} = Very low problem confrontation; P_V = Low problem confrontation; P_M = Medium problem confrontation; P_L = Large problem confrontation; P_{VL} = Very large problem confrontation

- Logit model was used to determine the factors affecting access to credit for farmers, since credit access is an important factor for profit maximization, especially for smallholder farmers. The binary logistic model was applied to understand the determinants in this regard. The generic form of the logit model, as presented by Dzadze et al. (2012), is:

$$\text{Logit } P(Y) = \beta 0 + \Sigma \beta i Xi + \mu$$

where, Yi = 1 if yes i.e. respondent has access to credit; Yi = 0 if no i.e. if respondent did not have access to credit; Xi = independent variable; β0βi = logistic coefficient for independent variable; μ = error term.

- The dual impacts of the COVID-19 pandemic and Amphan super-cyclone which affected the region in May, 2020 have been analysed using both descriptive and analytical statistics such as mean, standard deviation, frequency and percentages for analysis and interpretation of data.

Results

Constraints analysis

To maintain betel vine productivity and increase farmers' incomes, it is important to identify the constraints/problems faced by individual farmers in different stages of the crop's cultivation and marketing. These were identified as-

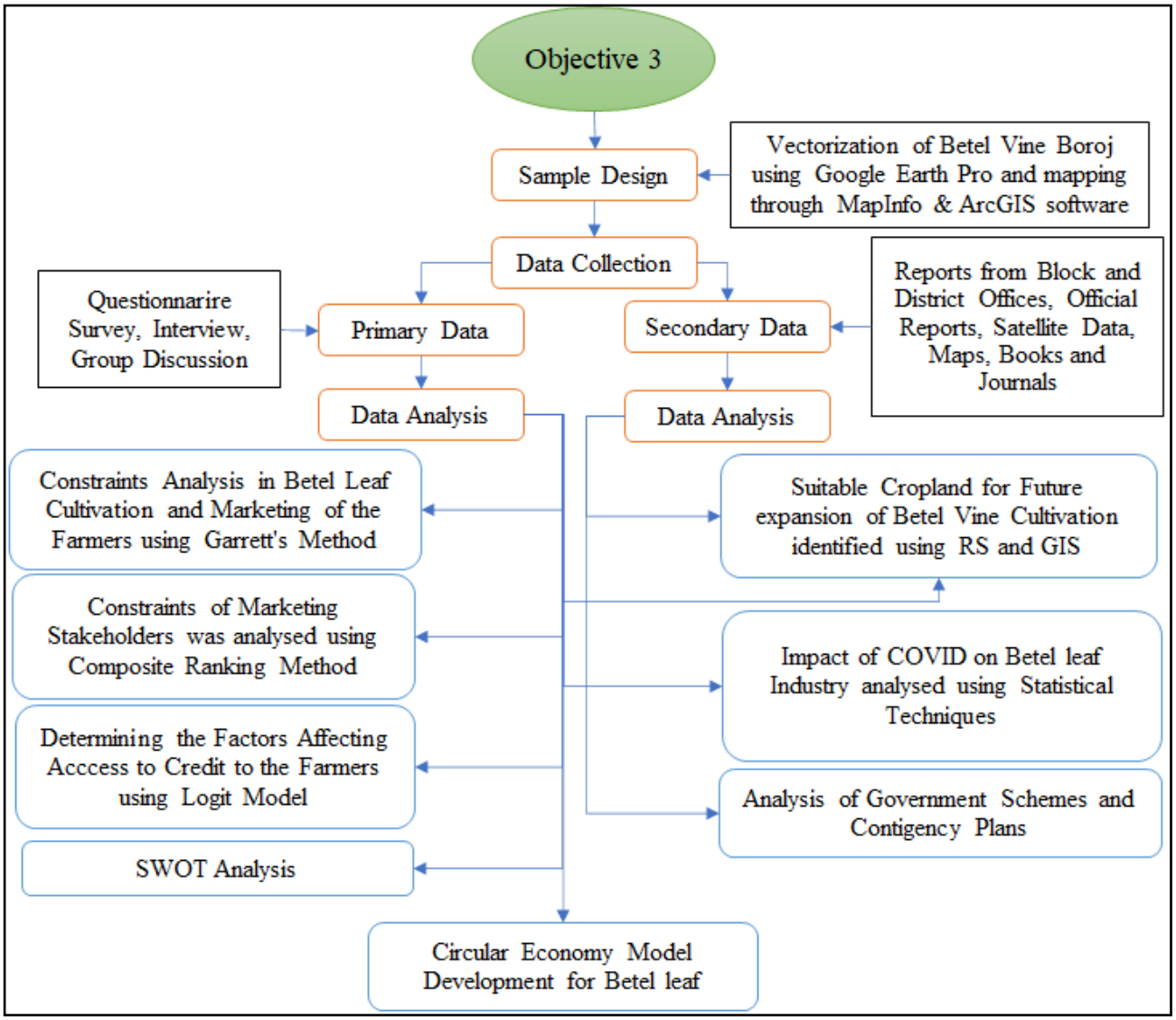

Objective 3
Sample Design
Vectorization of Betel Vine Boroj using Google Earth Pro and mapping through MapInfo & ArcGIS software
Data Collection
Questionnarire Survey, Interview, Group Discussion
Primary Data
Secondary Data
Reports from Block and District Offices, Official Reports, Satellite Data, Maps, Books and Journals
Data Analysis
Data Analysis
Constraints Analysis in Betel Leaf Cultivation and Marketing of the Farmers using Garrett's Method
Suitable Cropland for Future expansion of Betel Vine Cultivation identified using RS and GIS
Constraints of Marketing Stakeholders was analysed using Composite Ranking Method
Impact of COVID on Betel leaf Industry analysed using Statistical Techniques
Determining the Factors Affecting Acccess to Credit to the Farmers using Logit Model
Analysis of Government Schemes and Contigency Plans
SWOT Analysis
Circular Economy Model Development for Betel leaf

Fig. 29: Methods flowchart for third objective

Constraints against cultivation: FC1- Lack of labour supply, FC2- Lack of water, FC3- Plant diseases and pest attacks, FC4- Natural calamities and lack of subsidies in their aftermath, FC5- Need for daily maintenance of the betel leaves, FC6- Lack of fertilizer and pesticide, FC7- Improper irrigation management, F8- Polluted water during irrigation, FC9- Land/plot availability, FC10- Soil quality, FC11- Lack of quality betel vine seeds, FC12- Wrong/inefficient pesticide management, FC13- Lack of government support and unavailable insurance facility, FC14- High input costs, FC15- Lack of credit facilities and non-availability of loans.

Constraints against marketing the betel leaf produce: FM1- Fluctuating leaf price, FM2- Numerous market intermediaries or middleman, FM3- Lack of packing material, FM4- High transportation costs and poor transport accessibility, FM5- High market commission charges, FM6- Lack of market price information, FM7- Improper selling methods, FM8- Non-availability of storage facilities, FM9- Unauthorized deductions and competition with other betel leaf growing areas, FM10- Excessive leaf wastage during low demand and high production periods

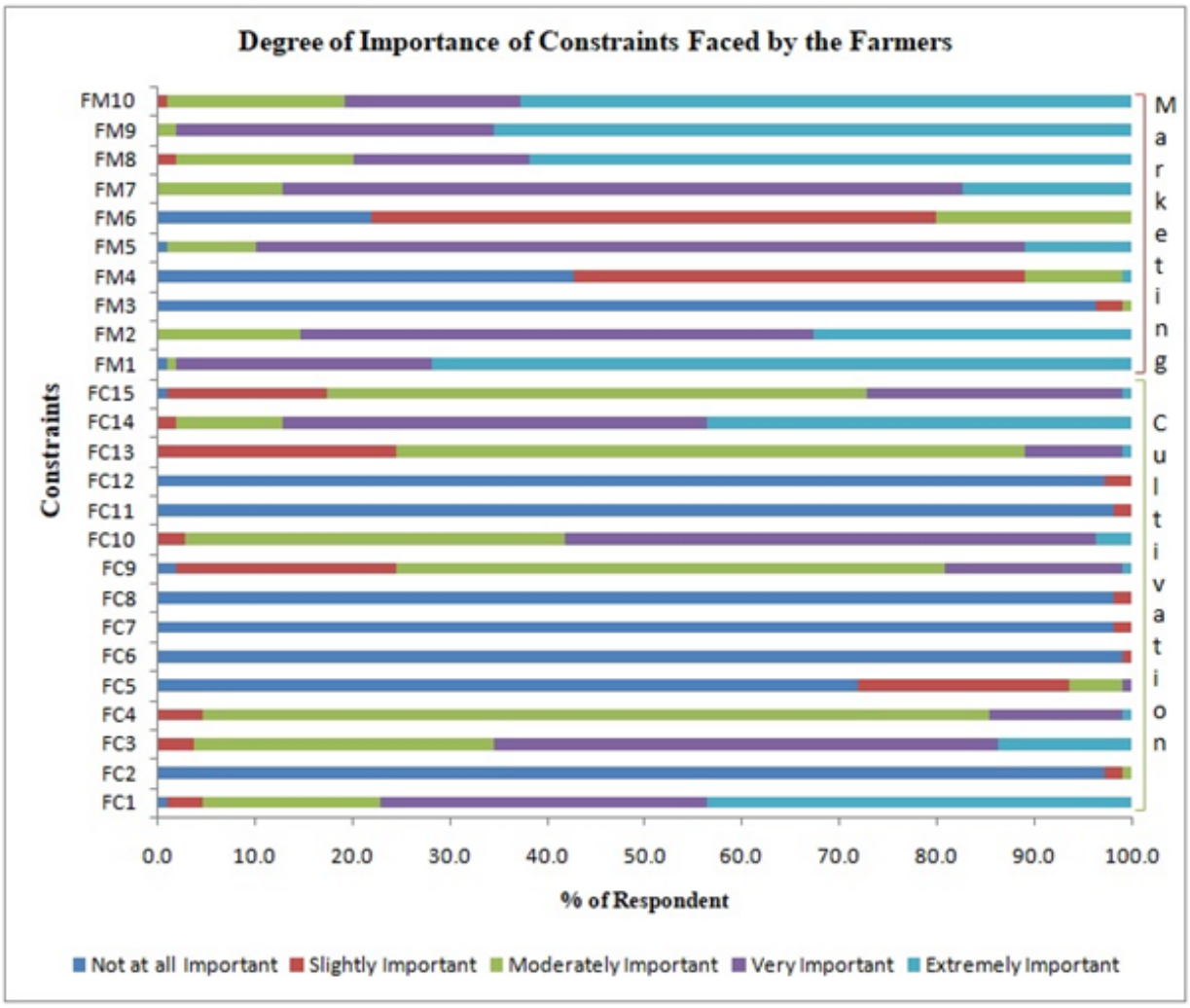


Fig. 30: Importance of cultivation and marketing constraints faced as per respondent farmers

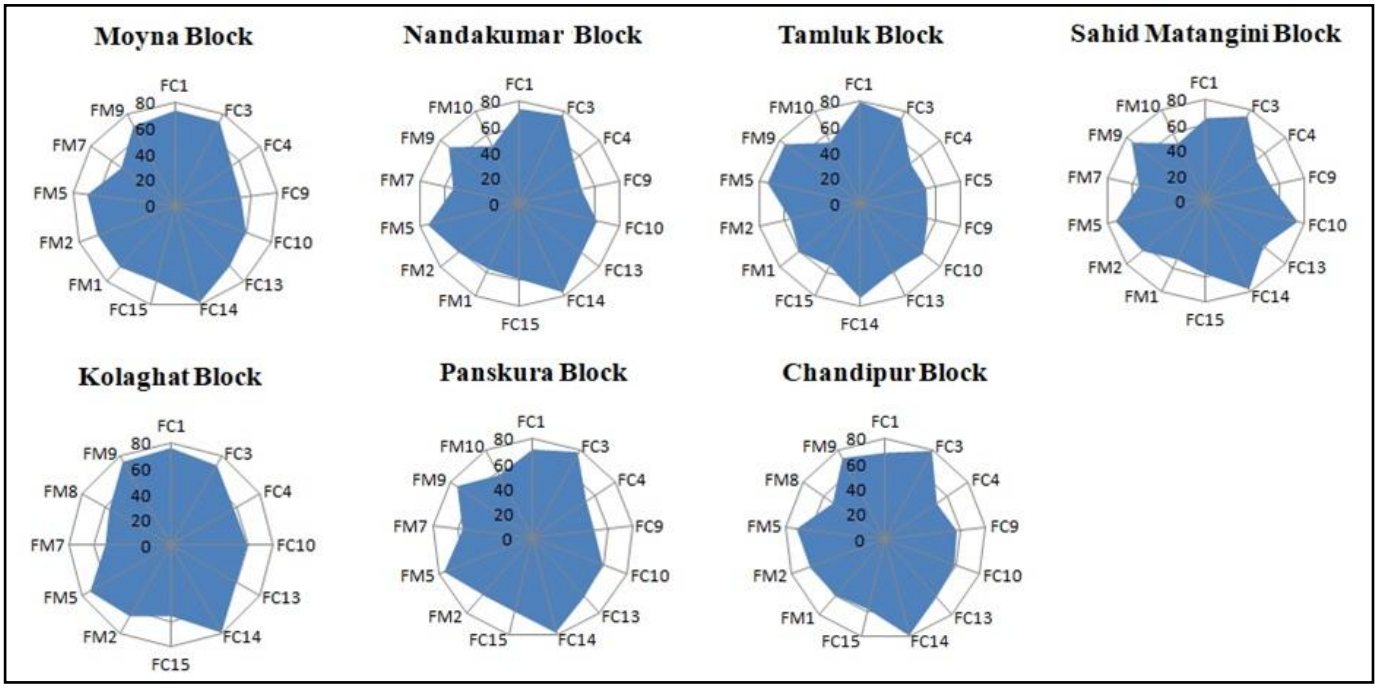


Fig. 31: Relative extents of the different constraints to betel leaf cultivation and marketing

The constraints identified were classified using the five-point Likert Scale as per the degree of impediment caused. Those considered as moderately to extremely important by most respondents (Fig. 30) were the lack of labour supply (by 95.5%), leaf diseases and pest attack (96.4%), natural calamities and lack of government subsidies in their aftermath (95.5%), unavailability of proper land/soil (75.5%), poor/declining soil quality (97.3%), lack of government support and insurance facilities (75.5%), high input costs (98.2%), lack of credit facility and non-availability of loans (87.7%), fluctuating leaf price (99.1%), numerous intermediaries or middleman (100%), high market commission charges (99.1%), improper selling methods (100%), non-availability of storage facility (98.2%), unauthorized deductions and competition from other areas (100%), and finally, excessive wastage during low demand and high production periods (99.1%).

The main constraints to profitable betel leaf production were those factors whose mean Garrett's score was ≥50. Ranked from 1st to 8th, these were- high input cost of *Boroj* setup or crop planting (77.03), leaf diseases and pest attacks (75.25), lack of labour supply (72.91), poorer/diminished quality/fertility of soil (63.30), lack of government support and insurance (60.49), lack of credit and loan availability (58.35), natural calamities and the lack of subsidies thereafter (52.34), and diminishing availability of good soil/land plots (51.35). While these issues were faced by almost all respondents, spatial variations in factor ranks was evident at the Block level (Fig. 31).

Since constraining factors rarely operate singularly, the cumulative effect of the foremost impediments was analyzed. Together these three aspects (Fig. 32a) were ranked as the top-three issues affecting cultivation by 87.27% of respondents. In the five-member grouping (Fig. 32b), the most important issue was again high input costs together with leaf disease/pest attacks (20%), labour supply (19.82%), soil quality (14.36%) and minimal government support (12.91%). Overall, 87.09% of respondents stated these as the top-five constraints.

Among the ten marketing constraint factors identified, six were considered as very important, each having a mean Garrett's score of <50. Unauthorized leaf price deductions by middlemen and competition with other betel leaf growing areas (72.58) ranks as the biggest constraint. Other prominent impediments, in descending order of importance are, commission charges (72.29), numerous middleman/intermediaries (61.75), fluctuating leaf price (56.90), improper selling method (52.42), excessive wastage during low demand and high production periods (50.09), non-availability of storage facilities (49.48) and non-availability of current market price information (37.48).

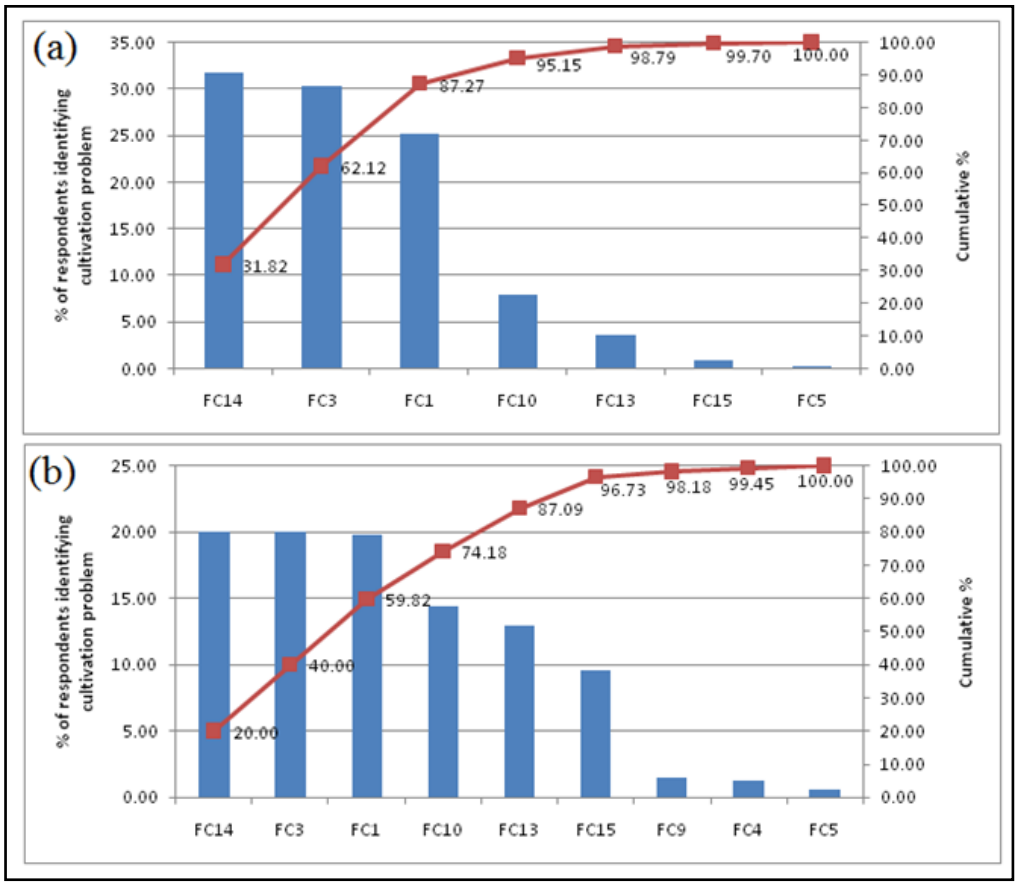


Fig. 32: Pareto Chart for cultivation constraints (a) first three cumulative choices, and (b) first five cumulative choices

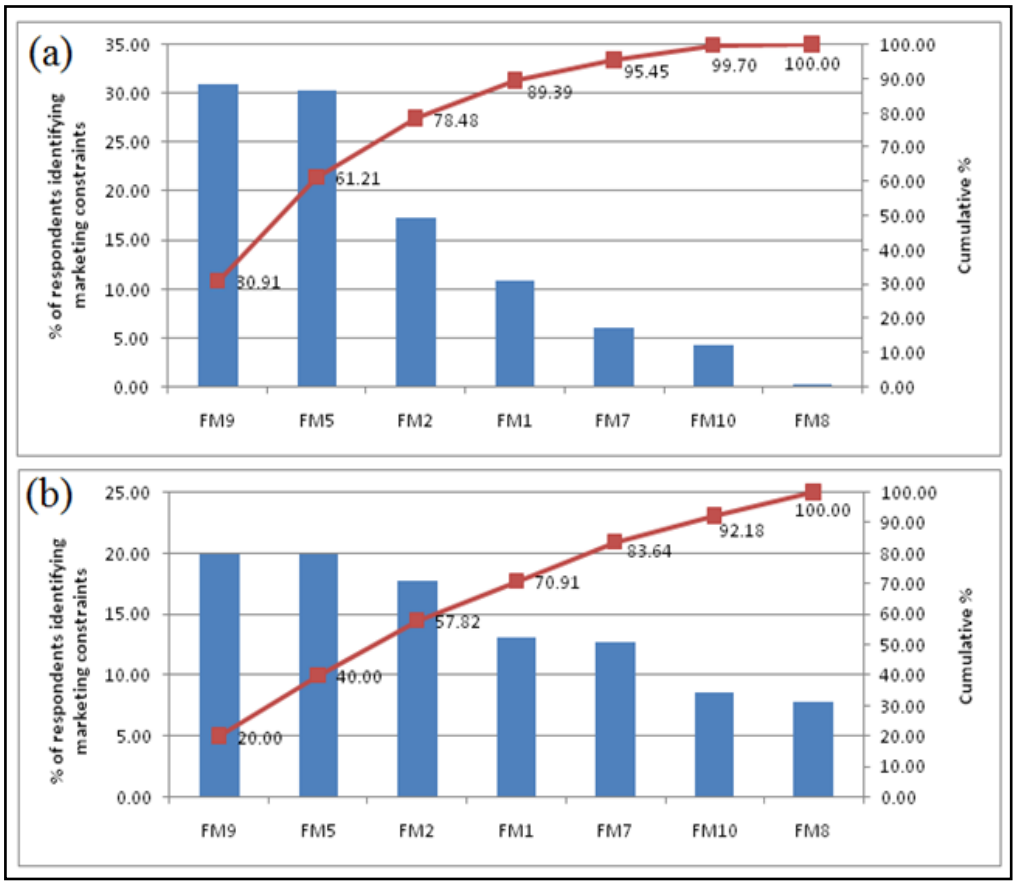


Fig. 33: Pareto Chart for marketing constraints (a) first three cumulative choices, and (b) first five cumulative choices

Cumulative groupings were also done for these marketing constraints on a three and five-set ranking basis. Both times, unauthorized price deductions and competition with neighbouring areas was identified as the main problem, by 30.91% and 20% of farmers, respectively. In the three-factor set (Fig. 33a), the other two major impediments were the high commission charges levied (stated by 30.30%) and the numerous middlemen involved (17.27%). Overall, 78.48% respondents felt these were the top three impediments to leaf marketing. The same three factors were also prominently present in the five-set group, with the price deduction and commission charges factors each noted by 20 per cent of farmers and the middlemen factor by 17.82%. Added to this were the leaf price fluctuation (13.09%) and improper selling method (12.73%) issues, with these five factors together stated by 83.64% of respondents (Fig. 33b). The top-three constraints in respect of both cultivation and marketing identified village-wise (Fig. 34a and 34b) do not show any marked spatiality, pointing to the universality of these impediments herein. Ameliorative measures shall thus benefit cultivators throughout the area and need not be very site-specific.

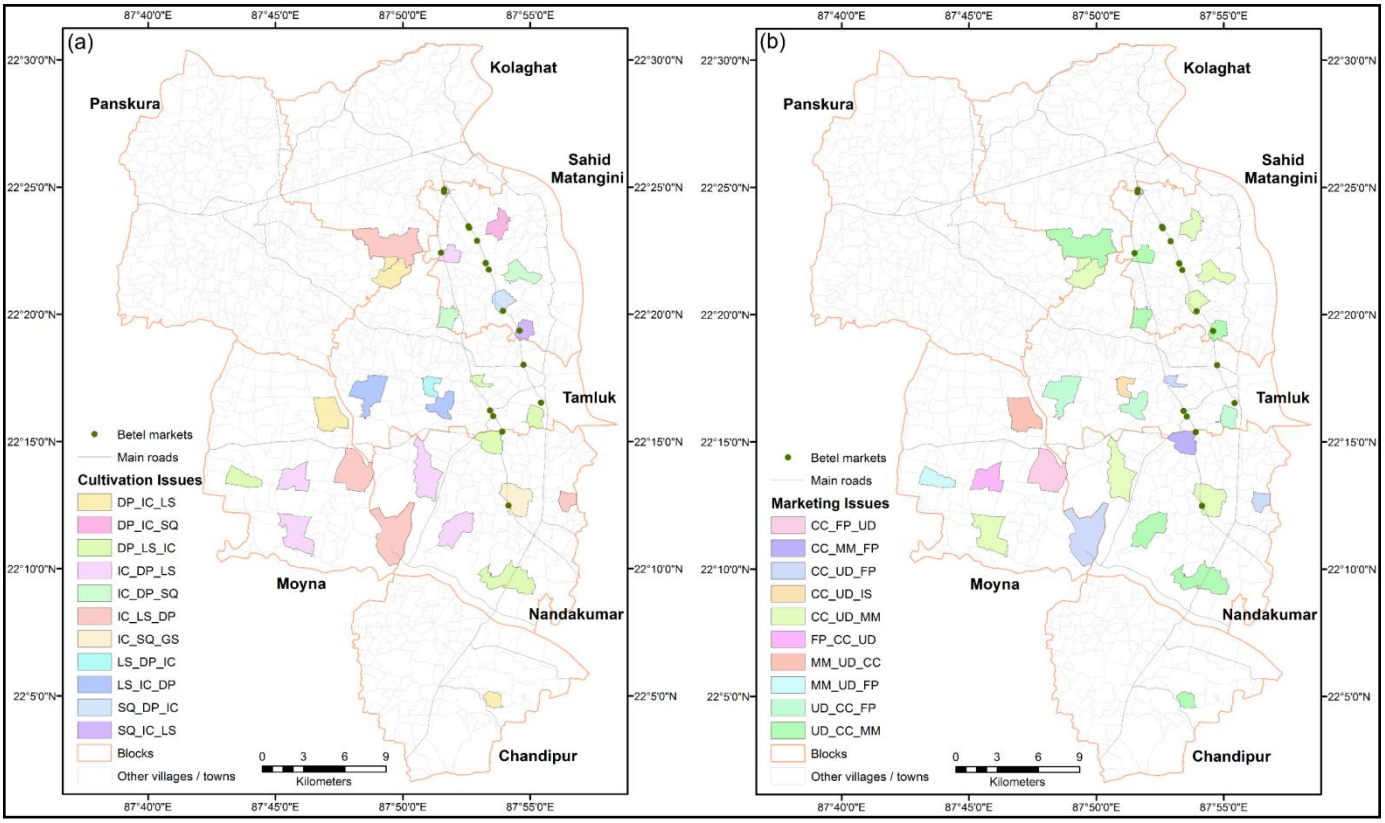


Fig. 34: Main impediments to betel leaf industry in Tamluk Sub-Division (a) Cultivation constraints, (b) Marketing constraints

Note: DP: leaf disease and pest attacks; IC: high input costs; LS: lack of labour supply; SQ: poor soil quality; GS: lack of government support; CC: high commission charges; FP: fluctuations in leaf price; UD: unauthorised price deductions; MM: multiple middlemen; IS: improper selling method

Marketing stakeholders also face several constraints, but these are quite different. The commission agents' or traders problems (Table 22) are related to lack of government support (Rank 1), no security of payment from outstation traders (Rank 2), no loan facility (Rank 3), non-availability of insurance for betel leaf marketing (Rank 4), insufficient wagons in goods trains (Rank 5). *Aratdar*s (Table 23) on the other hand, face far fewer issues in marketing betel leaves, with price fluctuation (Rank 1), non-availability of credit (Rank 2), trading in a highly perishable commodity (Rank 3), insufficient labour and low market demand (Rank 4) and lack of good quality leaves (Rank 5) being their main impediments.

Table 22: Stakeholders' (Commission Agents'/ Traders') problem in marketing of betel leaf

Commission Agent/Traders Problem		
Problems	**Garrett's Mean Score**	**Rank**
TMP1	42.12	11
TMP2	78.50	1
TMP3	57.62	6
TMP4	45.50	9
TMP5	31.69	13
TMP6	40.58	12
TMP7	45.27	10
TMP8	52.27	8
TMP9	52.65	7
TMP10	61.52	4
TMP11	28.00	14
TMP12	59.19	5
TMP13	63.42	3
TMP14	76.67	2

Note: 1. C, Lack of Government support, 3. Price fluctuation, 4. Lack of export promotional activity, 5. Transportation Problem, 6. High labour cost, 7. High rate of packing cost, 8. Low market demand, 9. highly perishable commodity, 10. Non availability of insurance facility, 11. High transport cost, 12. Insufficient carriage and wagon bogies in train, 13. No loan facility, 14. No security to get money from outside traders

Table 23: Stakeholders' (*Aratdar*s') problems in marketing of betel leaf

***Aratdar*s Problem**		
Problems	**PCI**	**Average PCI**
AMP1	203	4.06
AMP2	90	1.80
AMP3	120	2.40
AMP4	120	2.40
AMP5	182	3.64
AMP6	198	3.96

Note: 1. Price fluctuation, 2. Lack of good quality leaves, 3. Insufficient labour, 4. Low market demand, 5. Highly perishable commodity, 6. Non availability of loan facility

Logistic Regression

Collinearity statistics (Table 24) of logistic regression revealed that there is no multicollinearity (tolerance is more than 0.1 and VIF is less than 2 for all the variables) present between the variables used in the model. Omnibus Tests of Model Coefficients (Table 25) showed that the model is significant at the 5% level of significance and this was also verified by the Hosmer and Lemeshow Test (Table 26), that ratified the model's significance. Cox and Snell's R Square and Nagelkerke's R Square values (Table 27) reveal that the explanatory variables explained the dependent variable from 12.3 % to 16.8%. Table 28 shows that the explanatory variables *Annual income* and *Experience of farmers* are significant at 5% level.

Table 24: Collinearity statistics for logistic regression

Coefficients[a]			
Model		**Collinearity Statistics**	
		Tolerance	**VIF**
1	Cultivator's Educational Status	.954	1.048
	Annual income	.964	1.037
	Year of experience in betel cultivation	.988	1.013

a. Dependent Variable: Bet Farmers get Credit Facility

Table 25: Omnibus Test for model coefficients

Omnibus Tests of Model Coefficients				
		Chi-square	df	Sig.
Step 1	Step	14.839	3	.002
	Block	14.839	3	.002
	Model	14.839	3	.002

Table 26: Hosmer and Lemenshow Test for model significance

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	6.295	8	.614

Table 27: Model summary of logistic regression

Model Summary			
Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	137.508[a]	.126	.168

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 28: Explanatory variables' significance

Variables in the Equation									
								95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Education	.147	.089	2.770	1	.096	1.159	.974	1.378
	Annual income	.000	.000	4.345	1	.037	1.000	1.000	1.000
	Experience	.069	.024	8.378	1	.004	1.071	1.023	1.123
	Constant	-4.464	1.380	10.461	1	.001	.012		

a. Variable(s) entered on step 1: Education, Annual income, Experience.

Episodic disturbances: COVID-19 induced lockdown and Amphan super-cyclone

The COVID-19 pandemic induced lockdown and the Amphan super-cyclone caused marked distress to the farmers. These recent disturbances are quite important, as only by mitigating their effects and aiding in the recovery of this agribusiness sector can this important economic pursuit become fruitful again. Although, the production (growth) of betel vine had remained almost the same during the lockdown period, the farmers did not pluck the betel leaves from their respective *Borojs* due to the obvious less demand during this period and thus the actual marketable production of betel leaf (i.e. the amount of leaves that were transferred by the farmers or the *Aratdar*s from the farms/*Boroj*s to the market for selling) decreased drastically (Table 29).

Table 29: Difference in betel leaf production (in terms of amount of leaves sent by farmers to the market) during normal times and during the COVID-19 lockdown period

Production in thousands/10 decimal/month				
	***Bangla* Variety**		***Mitha* Variety**	
	Normal Time	**COVID-19 lockdown**	**Normal Time**	**COVID-19 lockdown**
Mean	7954.55	3227.27	7214.29	2542.86
SD	1572.49	847.46	951.19	496.18

The regular supply chain thus became quite disrupted in the early phases of the lockdown in the months of March and April 2020, leading to the formulation of alternate channels (Fig. 35), that were limited in their geographical ambit (i.e. only catering to markets within West Bengal and its neighbouring states). By May 2020, when some transport restrictions had been eased, a newer form of the supply chain had evolved (Fig. 36), which was similar to the pathways that existed in the pre-lockdown era. Fig. 37 shows the sharp fall in the market price of betel leaves in Tamluk Sub-Division due to the initial lockdown effect in April 2020, and then its delayed rise back to the former levels due to the *Amphan* devastation effect.

The gross returns analysis shows that smallholder betel leaf farmers faced substantial loss during the COVID-19 lockdown (Fig. 38). The average loss for those producing *Bangla* and *Mitha*

betel leaf varieties were Rs. 8359.09 and Rs. 13803.57 per 10 decimal per month, respectively. Even though there was a variation in the stated gross returns among the respondents (standard deviation Rs. 1643.17 and Rs. 202.26 for *Bangla*; and Rs. 1017.70 and Rs. 307.88 for *Mitha* variety) mainly due to the differences in yields and overheads of these two leaf types, the necessity of improving the agro-economic condition of the famers was apparent, along with ensuring robust supply chains.

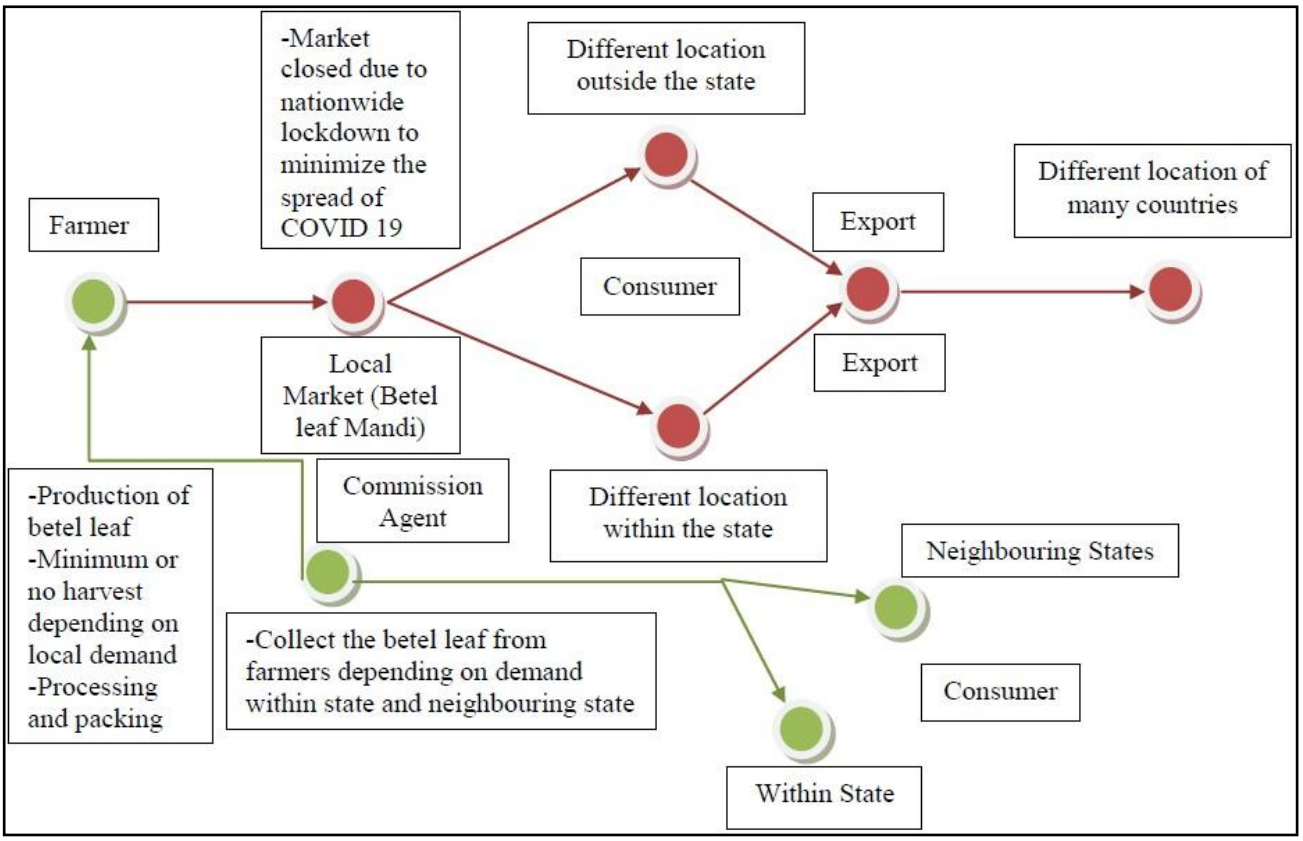

-Market closed due to nationwide lockdown to minimize the spread of COVID 19
Different location outside the state
Different location of many countries
Farmer
Export
Consumer
Export
Local Market (Betel leaf Mandi)
Commission Agent
Different location within the state
-Production of betel leaf
-Minimum or no harvest depending on local demand
-Processing and packing
Neighbouring States
-Collect the betel leaf from farmers depending on demand within state and neighbouring state
Consumer
Within State

Fig. 35: The modified channels of betel leaf supply during the lockdown
Note: The red circles and arrows indicate channels that did not function due to the lockdown.

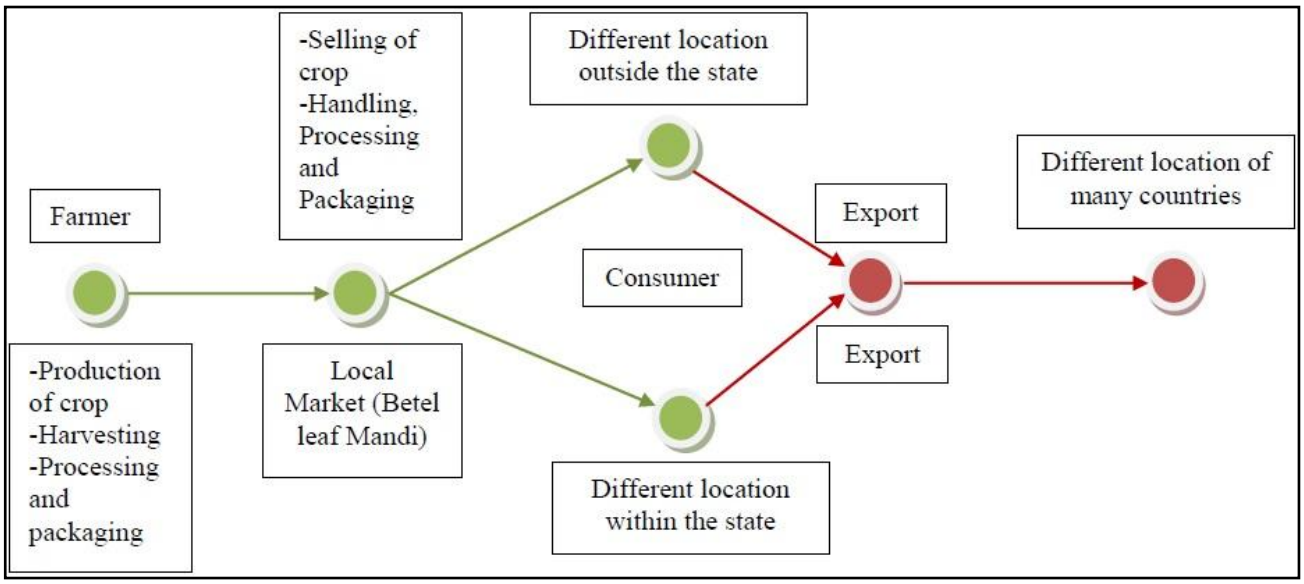


Figure 36: The emergent betel leaf supply channels after the markets reopened
Note: Red circles/arrows indicate channels not functioning due to existing restrictions after lockdown phases.

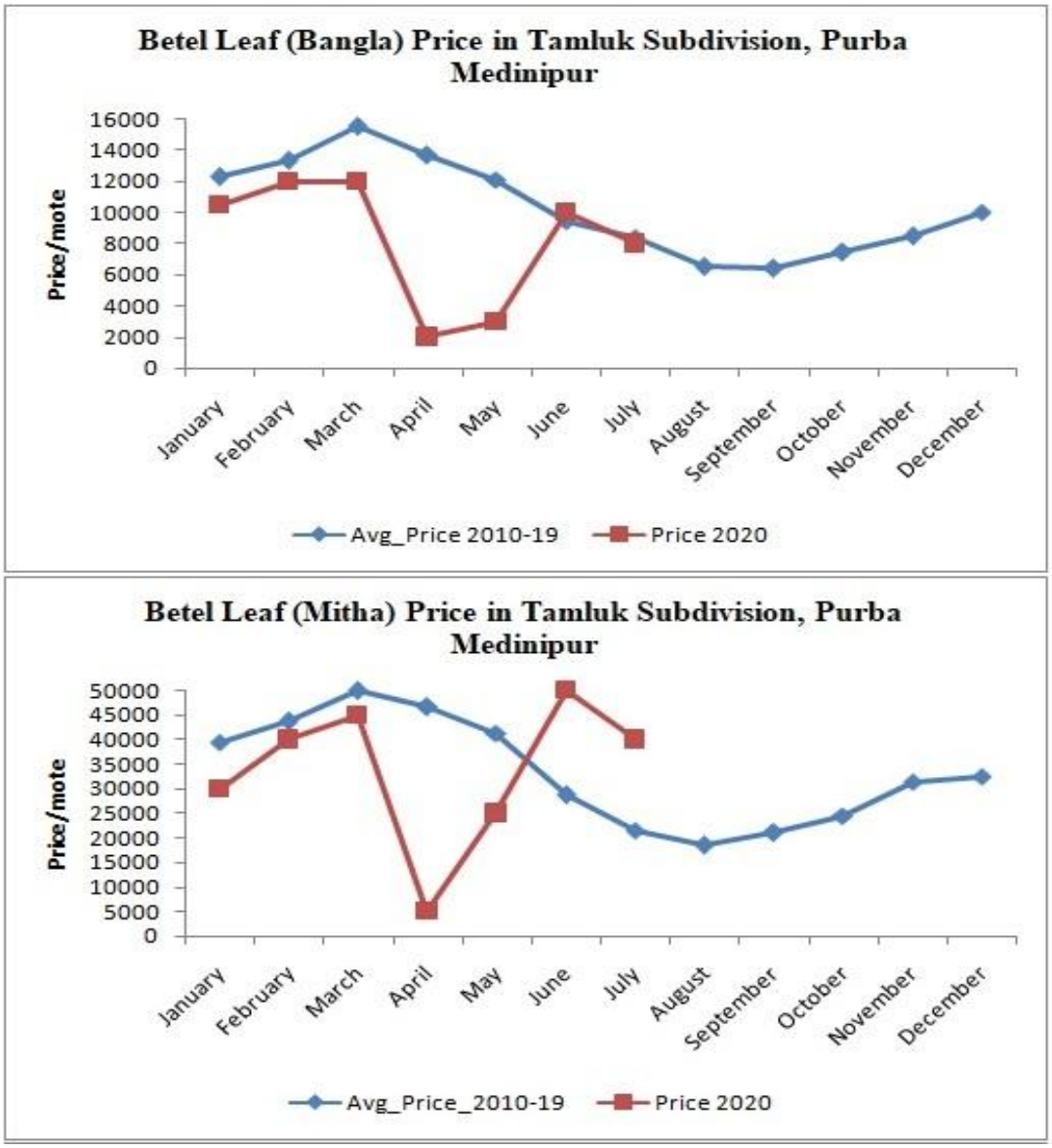


Fig. 37: The sharp drop in the betel leaf price due to the combined effect of the lockdown and Amphan super-cyclone, for the two main varieties of leaf (*Bangla* and *Mitha*)

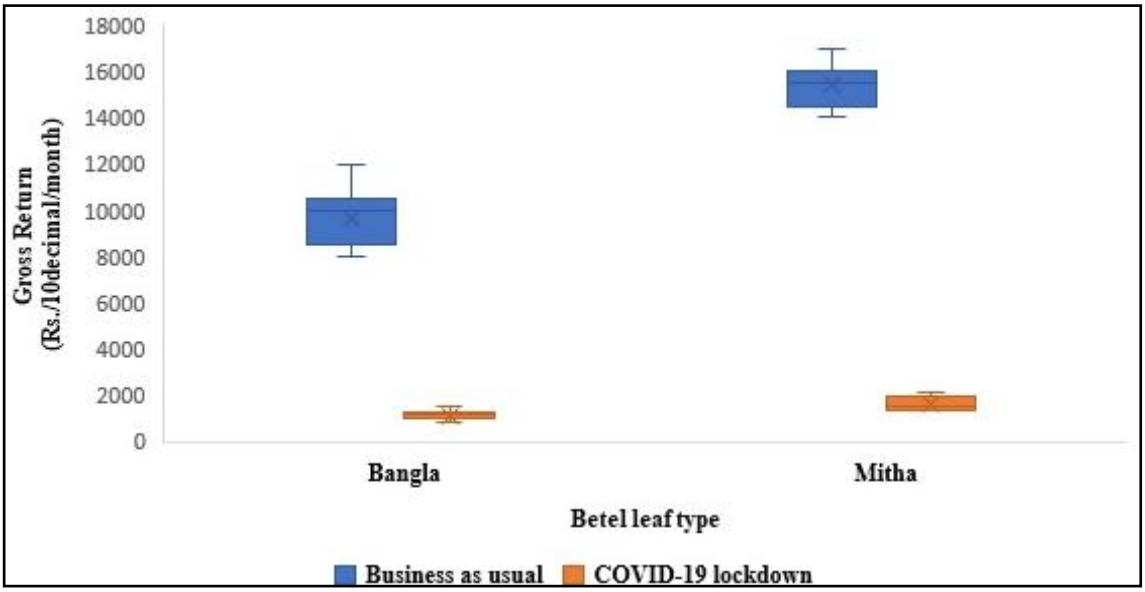


Fig. 38: Difference in the gross earnings from the two main betel leaf varieties cultivated in the study area due to the pandemic

Circular Economy approach and SWOT analysis

Due to the inherent constraints and impediments faced by the betel leaf agribusiness in Tamluk Sub-Division, it is important to analyse how the available resources and agribusiness structure can be restructured utilising a Circular Economy (CE) model approach (Fig. 39), rather than persisting with the linear economy concept (Fig. 40), which is followed at present. Here an attempt has been made to examine and illustrate how the local and regional resources were utilized towards the CE principles in the regional context and to suggest a structural framework that can be adapted by the stakeholders towards circular economy and sustainable growth of betel leaf agribusiness.

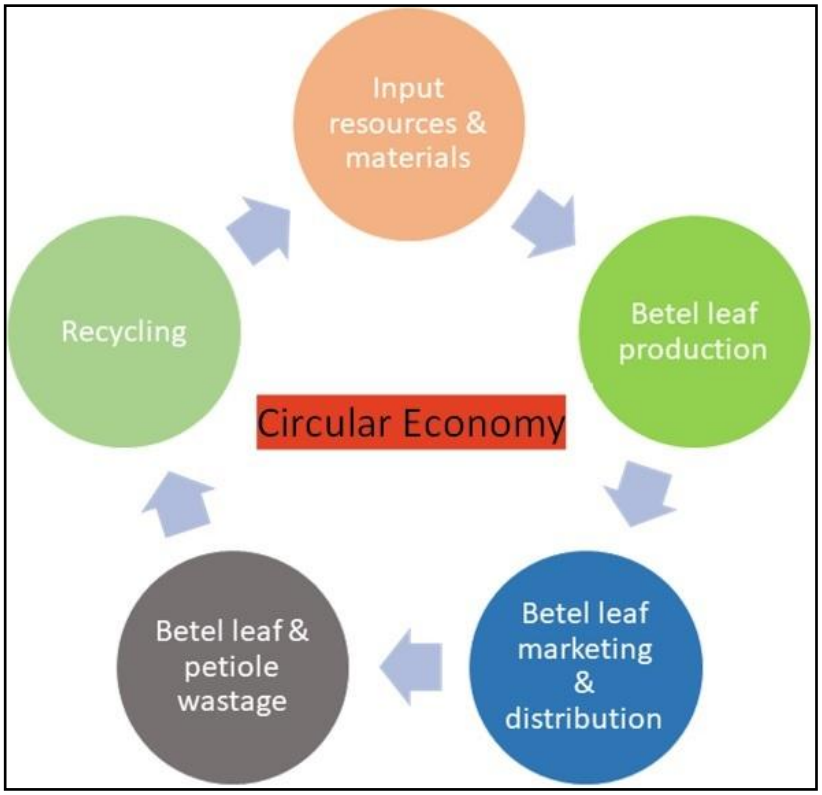


Fig. 39: Concept of Circular Economy in betel leaf agribusiness

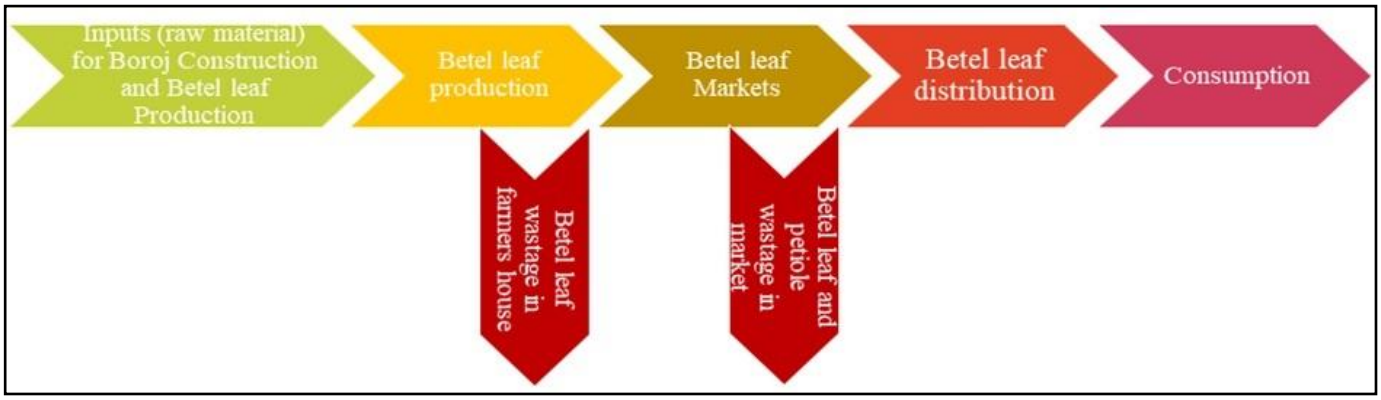

Inputs (raw material) for Boroj Construction and Betel leaf Production
Betel leaf production
Betel leaf Markets
Betel leaf distribution
Consumption
Betel leaf wastage in farmers house
Betel leaf and petiole wastage in market

Fig. 40: Existing Linear Economy in betel leaf agribusiness

Therefore, reducing betel leaf spoilage and its petiole waste from different markets and farms, particularly during the low demand and monsoon season (Guha, 2007) can help farmers and other stakeholders by reusing this for producing organic fertilisers at low cost and other by-products. The proposed model/framework shows how this may be done (Fig. 41). This can augment

sustainable livelihoods and economic development herein. In this respect, a SWOT analysis was undertaken (Fig. 42) to gauge ways in which the various stakeholders may cope with the present constraints, while maximizing possible benefits and minimizing risk. The various external and internal influencing factors, with self-explanatory points are provided within the diagram itself.

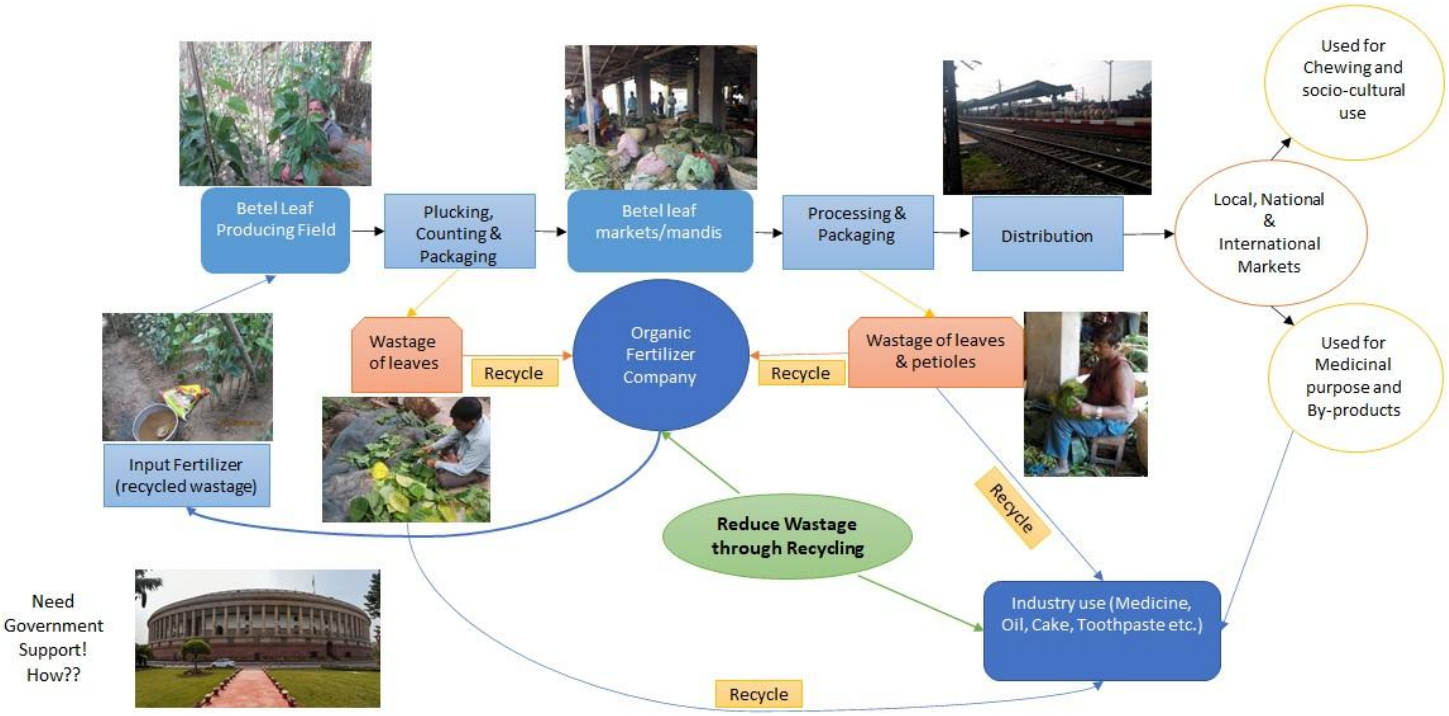


Fig. 41: Proposed Circular Economy model for betel leaf agribusiness

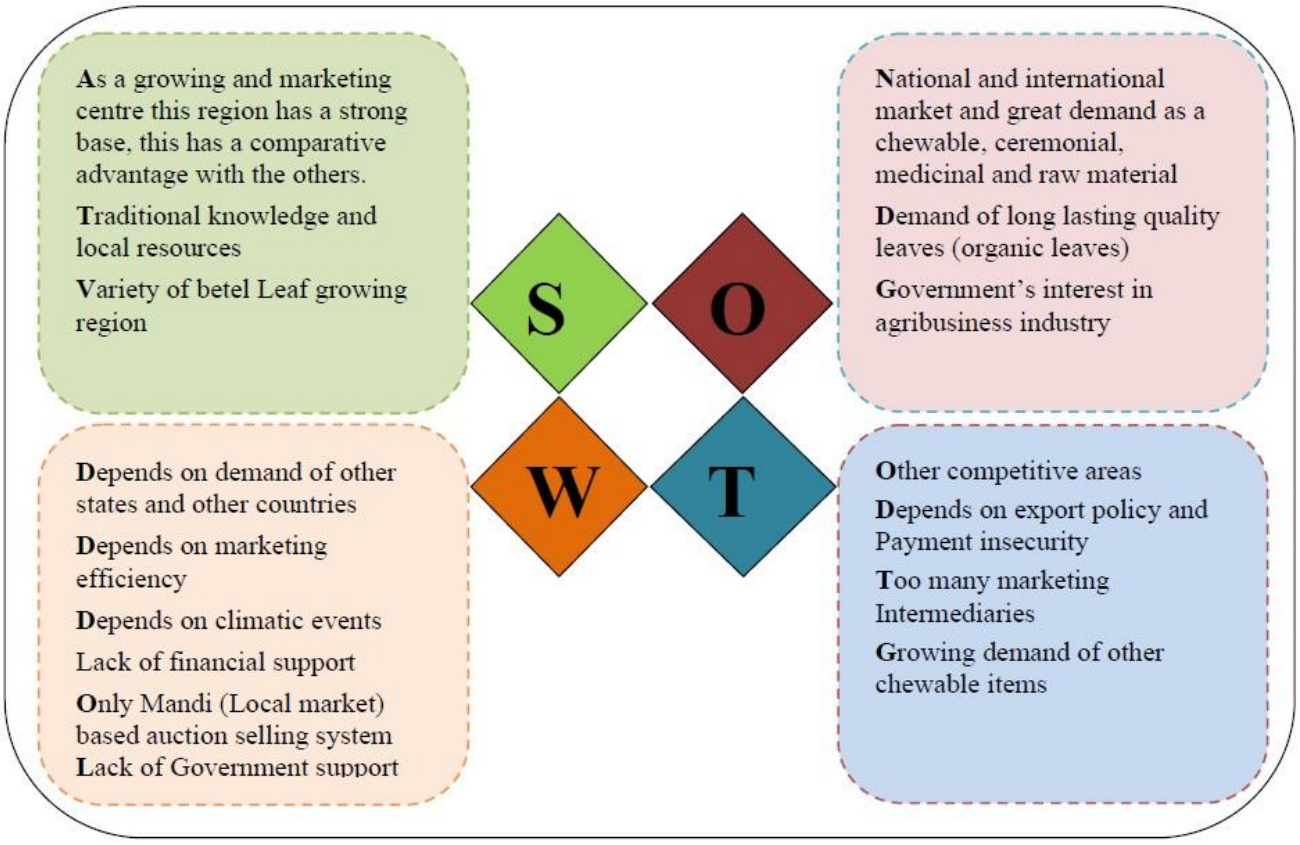

As a growing and marketing centre this region has a strong base, this has a comparative advantage with the others.
Traditional knowledge and local resources
Variety of betel Leaf growing region
S
O
National and international market and great demand as a chewable, ceremonial, medicinal and raw material
Demand of long lasting quality leaves (organic leaves)
Government's interest in agribusiness industry
W
T
Depends on demand of other states and other countries
Depends on marketing efficiency
Depends on climatic events
Lack of financial support
Only Mandi (Local market) based auction selling system
Lack of Government support
Other competitive areas
Depends on export policy and Payment insecurity
Too many marketing Intermediaries
Growing demand of other chewable items

Fig. 42: SWOT analysis on prospects of betel leaf cultivation and trade in Tamluk Sub-Division

Conclusion

The present study focuses on the viability of betel leaf agribusiness in Tamluk Sub-Division and through various analyses explores the prevailing conditions from the different stakeholders' viewpoints. It focuses primarily on betel leaf farmers and their sustenance from this crop. The younger generations are not much interested in continuing with traditional betel leaf farming due to several problems that affect its profits. Even though this crop is still viable from an economic viewpoint, the decreasing profits and increasing input costs hamper farmers' well-being. The study shows that market regulations are needed, particularly for minimizing the middlemen' margins in the betel leaf value chain so as to maximise farmers' profit. A high initial investment in *Boroj* setup to cultivate the *Mitha* variety of betel leaves can provide higher profits, but this is dependent on farmer access to credit availability, which is meagre and crop insurance and storage facilities, which are almost non-existent. Given the high value nature of this cash crop and the marked returns from its exports, government policies for formal credit, subsidy and crop insurance should be implemented. An added beneficial role would be controlling unauthorized leaf price deductions, maintaining proper selling procedures and providing minimum support price for farmers, while ensuring that commission agents get payment on time.

References

Agriculture Statistics, 2007. Department of Agriculture, Cooperation and farmers Welfare, Ministry of Agriculture and Farmers Welfare. Government of India,

Ali, Y. 2014. Problem Confrontation in Betel Leaf Cultivation by the Farmers in Natore District. MSc. Thesis, Sher-e-*Bangla* Agricultural University, Dhaka, *Bangla*desh.

Beura, S. 2007. Betelvine. In: Spices and Plantation Crop, by Jitendra Singh. 394-409. https://www.researchgate.net/publication/314837830

Bhakta, J.N. 2017. Betelvine Nature's Green Gold. NOVA Science Publishers, New York.

Christensen, L., Limbach, L. 2019. Finding common ground: Defining agricultural viability and streamlining multi-organization data collection. Journal of Agriculture, Food Systems, and Community Development, 8(suppl. 3), 137-152. https://doi.org/10.5304/jafscd.2019.08C.005

Council of Scientific and Industrial Research 1969. The Wealth of India, 8, 84-94. CSIR, New Delhi.

Development and Planning Department 2011. District Human Development Report, Purba Medinipur, 2011. Development and Planning Department, Government of West Bengal, Kolkata.

District Agricultural Evaluation Office 2014. Agricultural Evaluation Office (Admn.), Tamluk, Purba Medinipur. Department of Agricultural Evaluation, Government of West Bengal, Kolkata.

Guha, P. 2006. Betel leaf: the neglected green gold of India. Journal of Human Ecology. 19(2), 87-93.

Guha, P., Jain, R.K. 1997. Status Report on Production, Processing and Marketing of Betel Leaf (Piper betle L.). Agricultural and Food Engineering Department, IIT, Kharagpur, India.

Herath, H.M.J.K. 2015. Production and Marketing of Betel. Research Report No: 189, Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo.

ICAR (Indian Council for Agricultural Research), 1997. Annual Report of All India Coordinated Research Project on Betelvine. Indian Institute of Horticultural Research, Hessarghatta, Bangalore, India.

Jana, B.L. 1998. Arthakari phasal paan –o- paan chas prajukti (In Bengali) [Betel leaf: A cash crop and its production technology]. Nabanna Bharati. 30 (9), 450-455.

Jane, N.S., Deshmukh, A.P. and Joshi, M.S. 2014. Review of study of different diseases on betelvine plant and control measure. International Journal of Application or Innovation in Engineering & Management 3(3), 560-563.

Kalaivanan, D., Ramesh, P.R., Suryanarayana, M.A., 2019. Assessment of Soil Fertility Status in major Betel Vine Growing Soils of Tumkur District of Southern Karnataka for Sustainable Production. International Journal of Current Microbiology and Applied Sciences. 8(10), 1751-1765.

Krugman P. 1991. Geography and Trade, MIT Press, London.

Mishra, D., Mishra, S.K., Acharya, A., Das. J.N. 1997. Annual Report of All India Coordinated Research Project on Betelvine. Department of Plant Pathology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, India.

NABCONS, 2007. Comprehensive District Agricultural Plan for Purba Medinipur District, West Bengal, XIth Plan Period, NABARD Consultancy Services PVT. LTD., West Bengal

Nalwadi, S.R., Khan, H.S.S., Karnool, N.L., Vijaykumar, H.S. 1997. An Economic Analysis of Marketing of Betel Leaves in Dharwad District (Karnataka). Karnataka Journal of Agricultural Science, 10(2), 456-460.

National Agriculture Policy, 2000. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers welfare, Government of India, New Delhi.

National Policy for Farmers, 2005. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and farmers Welfare, Government of India, New Delhi.

National Policy for Farmers, 2007. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and farmers Welfare, Government of India, New Delhi.

Reddy, J., 2015. A Step by Step Guide for Pan or Betel leaf Farming in India. Agri Farming, https://www.agrifarming.in/betel-leaf-farming

Saravaran, R., Maiti, S. 2008. Agronomic manipulations for crop production in Piper betle. National Seminar on Piperaceae- HarnesingAgro-technologies for Accelerated Production of Economically Important Piper Species, IISR, Calicut.

Singh, J., Dhillon, S.S. 1984. Agricultural Geography. McGraw-Hill Education Publishing, New Delhi

Singh. J.S. 1994. “Betelvine Cultivation in India”. Directorate of Extension, Ministry of Agriculture, New Delhi.

Spicka, J., Hlavsa, T., Soukupova, K. 2019. Approaches to Estimation the Farm-level Economic Viability and Sustainability in agriculture: A Literature Review. Agricultural Economics, 65(6), 289-297.